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Orthodontics

EVOLUTION, DEVELOPMENT, AND APPLICATION OF MYOFUNCTIONAL THERAPY IN ORTHODONTICS*

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SCIENCE is a perpetual endeavor to discover the truth in whatever direction it may be. It depends upon research. Research is an effort to find out what we need to know about a given subject. In fact, it is asking questions of nature, and interpreting nature's responses to classify them properly as a record of fundamental truth. In the development of the profession of medicine, which includes dentistry, there always has been and there is still a tendency to carry on by making use of a system of beliefs, rather than withholding until there has been accumulated a sufficient array of facts.

We are quite aware that much of our effort in the early days of the practice of orthodontics was devoted to the carrying out of practices which were lacking a scientific basis. Our effort was almost purely mechanical. Our conception of the sphere of our work was quite definitely circumscribed by the limited area upon which we were expending our efforts. But the pioneers of orthodontics were wise enough to realize that there were many fields which could, and eventually would, contribute much to our better understanding. You will all agree that during the past thirty or thirty-five years the collateral sciences have furnished us with a greatly clarified picture of our particular field, and at the same time they have given us a multiplicity of tasks which promise to give our growing profession a field upon which to work—a field which appears to expand continuously so that we are ever in pursuit of new truths to guide us in our every day practice, which truths furnish us with concepts which were entirely absent in the beginning.

Read at the Thirty-Sixth Annual Meeting of the American Association of Orthodontists, Los Angeles, Calif., July, 1938.

*The application of myofunctional therapy was illustrated by motion pictures.

It is quite impossible for any single individual, unless he be of superintelligence, to advance his knowledge steadily on all fronts, and expect to be proficient in every understanding that is required for complete knowledge. I had this fact brought to my recognition when in consultation recently with two biologists. I was seeking an answer to some of our problems, yet I was reminded in this consultation that the field of biology is so immense that each of these two men, each a specialist in his own particular field, freely admitted his ignorance of the other's special field of investigation. This gave rise to the thought that no person should feel inadequate if he is making one particularized endeavor to solve a biological problem. He should accept the position that he is but one very small unit, and that his efforts can embrace nothing more than a fragmentary phase of the whole subject, and that the ultimate good should result long in the future, when someone capable of correlation can bring together into a whole the salient facts produced by many thoughtful minds. Our knowledge cannot even then be considered complete, but it should furnish a definite field for operation which has advanced along every front.

Such a situation cannot be considered as having arrived at the ultimate; but, if there is such a thing in this world as an approximation to absolute knowledge, it may be found in the act of placing side by side the extreme points of view that can be formulated, recognizing that every question is many sided, and that between the one dominant idea and the other swings that great pendulum of contraries. It will probably be found that truth lies, if anywhere, in the bringing together in full illumination contrasts of the most opposite interpretations. If this can be done objectively, after long endeavor the truth will be found probably in neither extreme. Such philosophic consideration of our problems gives us some encouragement, and it certainly justifies the small efforts that we are making individually to arrive, at least, at the correct understanding of some particular truth, which may be employed with assurance of success when we come down to that personal sphere which we like to term our sphere of service. Taking the matter of scientific progress as a whole, as related to our profession, we find that the leaves of progress turn faster and faster, but the story that they tell is slow in its unfolding and we are slow in comprehending.

In my own endeavors many years ago I sought a new avenue of approach to problems that were at that time common and perplexing. I sought an unexplored path into the field of orthodontics which seemed to give promise of a simple and, at the same time, a greater and more comprehensive understanding of the art of practice illuminated by a sufficiently scientific background to make of it a structure built upon a solid foundation of truth.

To my mind the two most significant words in our language are balance and rhythm because they are articulate of two fundamental laws of universal importance. Without these guiding forces in active operation, chaos must reign in any sphere, whether it be in the biological world or in the inorganic.

During its early conception, the possibility of the influence of balanced function upon structural or architectural development of the human face could not be eliminated from my thinking. My acquaintance with the orthodontic

literature, up to that time, had not shown me that anyone had developed either theories or practices that included the proper consideration of the functional elements of the soft tissues in relation to facial form; and yet the truth was being daily impressed upon me that many of the maldevelopments which we were called upon to treat were being developed by the mal-use or imbalance of numerous groups of facial muscles.

At this point began a search of the literature in the field of biology to learn, if possible, results of experimentation which might give reason for a definite belief in the validity of the hypothesis which I had formulated, in relation to the influence of the functional elements which confront us in the field of orthodontics. Being a pragmatist, I set out to test my own theory; and, when, after considerable length of time, I found that the theory of increased function, or increased muscular activity, controlled with a definite purpose seemed to work, then my pragmatism seemed justified. Because you know that the pragmatist's philosophy, speaking broadly, may be said to be the theory that the test of truth is to be found in its practical consequences, and if the practical consequences are found to be satisfactory the thinking is said to be true. I further fortified myself with the thought that if it could be proved that that which works continuously in the desired manner, *that* which creates a tendency towards the normal *must be* in harmony with the nature of man's development. But, as already indicated, I was not satisfied that a pragmatic truth would be fully understood, or accepted, by the profession unless it carried with it the evidence of the laboratory, or, at least, the evidence of biological minds whose conclusions could, without doubt, be said to spring from the results of their personal labors and investigations.

It was then that the following briefly stated conclusions of authoritative minds furnished me with what seemed, at that time, to be sufficient ground for encouragement in the further pursuit of this one idea of functional efficiency or coordination in muscular function.

Dr. Dudley J. Morton[1] seemed at that time to give valuable support to my theory. In treating of the evolutionary changes of structure he has this to say:

"Structural alterations are not the result of any variation in mechanical laws as they effect the development of the bone, but are the natural sequence of a disturbance in the normal function in its relationship to the various tissues, whereby the mechanical laws are caused to work habitually in an abnormal or exceptional manner. The laws are immutable; it is the manner of use that changes, and structural modifications follow in accordance with the change in function. Hence the only logical interpretation is, that an altered employment of mechanical forces by a structure inevitably causes the original structure to be molded by those forces so that they may work more advantageously in the newly adopted manner; and by the same process, wasting follows nonuse. The actual alterations of bone structure are accomplished by two very simple and well-known processes, no matter if the alterations comprise marked changes of the entire structure or merely slight, localized rearrangement of the internal architecture; those processes are (1) increased growth, physiological hypertrophy, and (2) absorption, physiological atrophy, or diminished normal growth, as the case may be."

Dr. Morton continues: "In the first place, no other part of the body structure is affected by such violent forces as are exerted upon the comparatively small bones of the foot; in them the entire body weight is concentrated and its great stresses magnified by leverage. The average total of pounds per minute transmitted to the foot bones is far greater than in any other member of the body. Consequently, if any part of the entire skeleton may be supposed to show the influence of function as a remodelling factor, it would most surely and conspicuously be the feet.

"Modification of structure in the living individual to conform with the manner of use has been recognized and accepted by the medical profession.

"Such structural changes definitely tend toward improving that structure for a more efficient performance of the altered function. This law applies to changes secondary to disorders, as well as to physiological development of a part due to the long continued use of a specialized function.

"For example, the writer had the opportunity of making x-ray studies of the feet of one of our American champion sprinters during his last year in college. Not only were the metatarsal bones fully 20 per cent longer than those of the average individual, but other modifications were to be observed throughout the foot structure, which conformed specifically with the mechanical requirements of that specialized usage."

Professor F. Stanley Hall,[2] an investigator of unusual merit, said: "The muscles are in a most intimate and peculiar sense the organs of the will. They have built all the roads, cities, and machines in the world, written all the books, spoken all the words, and in fact have done everything that man has accomplished with matter. If they are undeveloped, or grow relaxed and flabby, the dreadful chasm between good intentions and their execution is liable to appear and widen. Character might, in a sense, be defined as a plexus of motor habits."

Every orthodontist must realize that the character of the individual patient has much to do with his success or lack of success, and that it sometimes answers the question why ofttimes wished-for results are so difficult of attainment.

I learned from Conklin[3] that, "Functional activity or use is one of the most important factors of development. Functional activity is response to stimuli, which may be external or internal in origin. The entire process of development may be regarded as an almost endless series of such responses on the part of the organism. . . . It is a truism that use strengthens a part and disuse weakens it; it is likewise a truism that responses which are oft repeated become more rapid and more perfect, and in this way habits are formed."

Noyes[4] says: "In the examination of any collection of skulls, the amount and arrangement of the bone of the alveolar process will be found to be an indication of the masticatory habits of the individual. In examining the sections through the bone of the alveolar process, the adaptation of the arrangement of bone to the force to be sustained should be constantly kept in mind.

"The muscular action of the lips and tongue are specially important in these last stages of growth, and particularly the forces that are generated by the action of the muscles in respiration and deglutition. The activity of the

connective tissue cells in the bone requires mechanical stimuli for their maintenance, and as the muscular action is vigorous or deficient, the growth of bone will be full and normal or imperfect and unbalanced."

Macewen[5] in his book on bone growth, after reviewing a series of experiments, says: "The effect of the soft tissues in maintaining the form of the bone may be considerable, even the weight of the tissues has its result. The tongue, physically at least, is a soft organ, and yet its complete removal often produces in the course of years a marked alteration in the shape of the lower jaw, which generally falls inward so as to permit the teeth to slope markedly toward the buccal cavity. Normally the form of the lower jaw is maintained by the soft tissues within the mouth."

Cryer[6] in his chapter on Muscle Action writes that: "The normal application of the forces affecting developing bone results in normal development of the form of the bone. Their abnormal application under the same circumstances results in the development of *abnormally formed* bone. Abnormal application of forces to the bone in adult life will also change and modify the shape and character of the bone tissue." Cryer then cites instances of the proof of his assertion which, although they do not apply directly to the jaws, nevertheless are convincing and true.

You will recognize that these quotations are not selected from recent works on biology, but are a few of the many encouragements given me by biologists years ago to continue in my endeavors to place before the profession the truths that would aid us in a practical sense, furnishing us with scientific reasons for pursuing our professional work as orthopedists who recognize the value of the elements of function in normal development, and in the maintenance of efficient physical performance.

Inasmuch as this paper is more or less an historical review, I shall use little space to extend evidences of more recent biological conclusions furnished by writers of the day; but I might say in passing that my personal contact with modern biologists tends to encourage the views that I have already expressed. They have expressed to me their confidence that these methods of practice are in accordance with biological thought or findings. Orthodontists are not biologists, and any biological knowledge which we do possess must, of necessity, come second-handed, and doubtless oftentimes is misconstrued, and a favorable side of a controversial subject may be selected as conclusive evidence of the rightness of our pet contention.

Murray[7] in his treatise on bones would lead us to believe that biologists in general recognize both intrinsic and extrinsic influences upon bone form, and recognize the dependency of normal later development upon the supervention of function. They agree also that curvature in the long bones may be caused either by the intrinsic growth pattern peculiar to the element or by the extrinsic factors produced by muscular tensions. They assert that there can be no doubt that unbalanced mechanical factors, especially when in excess of those acting normally, would bring about curvatures in the long bone which are in excess of the normal curvatures brought about by factors acting within the bone itself. We are also told that the intrinsic factors which direct the growth of the long

bone tend to cause it to assume the normal curve and normal architecture, but that extrinsic mechanical factors, when met with in excess, may overcome the intrinsic factors and cause a deviation from the normal in the development of bony structures; but that if the extrinsic factors are normal, they will favor the development of a part to its normal form.

We are informed also that the gross form of the bone is determined by the cartilaginous element which forms its scaffolding, and that the form of bone is not an exact copying of the cartilage, and under adverse circumstances it may be very different.

During all these years there have been those who have resisted the suggestions that myofunctional therapy consisted of anything more than an empirical attempt to carry out theories based upon suppositions. Resistance to complete acceptance of innovations has been typical of progress throughout the ages. We need look only at the history of medicine, ignoring entirely the history of other scientific advances, to discover that innovations have been consistently ignored until their truths have become so self-evident, so incontrovertible that they were finally accepted as real and fundamental.

Many individuals are apt to turn aside from exacting innovations and to continue the old methods which have a certain amount of utility, even if they are not as adequate as the new. The earlier methods of orthodontics are still being followed by some with a sense of great personal satisfaction, in spite of the fact that they have been superseded in effectiveness by later methods.

To one who accepts his daily tasks with complacency, innovations are a matter of easy disposal, but criticism usually comes from those who have an ambition to be thought of by their professional brothers as authoritative. And while their sincerity of purpose may not be questioned, it is a fact well recognized in medicine, at least, that nothing has retarded its progress more than the influence of the superior person to whom every innovation, and especially every suggestion from the world that lies beneath the clouds in which he dwells, is untrue and unacceptable. To be proud of intellectual isolation from the common thought of our professional associates, and to be disdainful of the importance of giving and accepting is as stupid as it is wicked, and may well bring the end of progress. It most certainly limits professional usefulness, and unity, and understanding. When criticisms emerge from sources whose authoritative opinion in some particular field may be accepted, but whose critical comment regarding another's experience is made without having traveled the same road, they are apt, on occasion, to be misleading to the younger members of the profession, and may result in turning their minds aside from a path which may eventually prove to be to them a stepping stone to higher achievement in their daily contact with their patients. If it were true that we all aim at true conclusions, criticisms would no doubt be given more honestly and with better purpose. The philosophic mind, as well as the scientific mind, aims at true conclusions as the mountain climber aims to reach the mountain top—he searches for the way to the top, the way that leads from the low lands of everyday experience, to view the whole landscape comprehensively.

The critic who offers his opinions without knowing, or caring why, is like the one who without personal effort has reached the mountain top. He is surrounded by the clouds, but without having experienced the labor necessary for his ultimate comprehension of the true values he has failed to attain.

One critical tendency I have found among orthodontists reveals an over-anxiety to devaluate, in the minds of their readers, the evident truths that give support to the value of myofunctional treatment as an aid in orthodontic procedure. There is one which had its birth at the very beginning, many years ago, and, in spite of its thinness, is still being used by those who would discourage further acceptance of the truths which some of us believe are fundamental. I refer to the argument that malocclusion often is self-correcting without mechanical interference, or without attention being given to the harmonious action of the various muscle groups. Such arguments constitute a reflection upon the intelligence of those whose experience has taught them to evaluate the true worth of myofunctional treatment. If you will pardon a personal intrusion, I should like to say that in my long experience one of the fundamental principles, that has always been foremost, is the recognition of the developmental elements intrinsic in the individual organism—that the basic principle that has always been used has been one of caution which has resulted in the practice of placing under observation, sometimes for long periods, those cases of malocclusion in young children that could possibly give encouragement to the principle of self-correction, and that the final result of such close observation has shown that no cases of real malocclusion have been discovered to be self-correcting without the aid of restored muscle function, but that those which have shown improvement have done so because of easily recognized conditions which favored the further normal development. Many of these have not been malocclusion in the true sense of the word, but have been nothing more than physiologic variations which might almost be considered normal in the developmental processes of the individual, and are confined principally to cases of neutroclusion. Again some of those which have shown improvement have been those where interference has been temporarily influential through the temporary mal-use of certain groups of muscular tissues.

We all know very well from experience that the habit of thumb-sucking will in some individuals result in a distortion of the premaxillary area. We also know that in some other individuals, where the vital processes are active, thumb-sucking seems to have no deleterious effect. Then again it has been observed by every one of you who has had any considerable experience, that with the correction of thumb-sucking the slight abnormal development of the premaxilla has disappeared. Among those who hold the view which we are at present discussing, such a favorable response would be hailed as an argument against the validity of myofunctional therapy, but which in reality is one of the best arguments in its favor.

Sometimes these critics will admit that the maxillary incisors may possibly be influenced to remain in their corrected positions if the orbicularis oris is induced to function normally by the use of certain exercises; but, in grudgingly

giving their assent to such possibility, they exhibit the limits of their experience by asserting that any other muscular function resulting favorably in promoting treatment and maintenance of treatment is to be very much open to question. No one proficient in the use of myofunctional therapy ever has asserted positively that mandibular growth, for instance, has been initiated by muscular pull, yet this has been used as an argument against the employment of muscular balance. Yet I venture to say that no one would care to assert that the architectural form of the bones is not influenced by function. They remind us, as though we do not already know it, "that growth as a physiological process is dependent upon some deep inherent characteristic of living protoplasm at present unknown." Such knowledge is not segregated for the few who would deny the advantages of functional activity in its influence upon a developing organism.

Doubters we must be in order that progress may not be sidetracked, because the honest doubter is the one who alone leads the advance of progress; and when any professional man varies from this attitude of the true scientist, I think it is well that he be honest with himself and search his deeper motives.

It is well known in medical history that the reception of a discovery, or an innovation, is often complicated by cliques within the profession, and by personality conflicts. As a young profession, and one in which there have arisen many conflicting theories and methods, it is necessary that we have recourse to conservatism, but *that* conservatism must in itself be guarded in order that valuable suggestions may not be unduly discounted. We are too young a profession yet to be guided by the authority of tradition, and for those who would circumscribe too carefully the value of myofunctional treatment the danger exists in establishing in the profession of orthodontics a tradition of mechanical treatment without the help of the functional elements of development. Just here I should like to mention the importance of the work being done by Dr. B. Holly Broadbent[8] in his scientific methods of charting the directions of growth in the growing organism. His data seem to give encouragement to those who advocate the simplicity, and the intermittent and limited use of orthodontic appliances in conjunction with the employment of carefully supervised functional activity.

To me it has always been a matter of wonder and concern that orthodontists, especially some who affect a scientific attitude toward the subject of orthodontics, should not alone fail to make an appraisal of the muscular elements of the face in their functional relationships, but who, even at times, discourage the attempt to lay emphasis on their importance. The animal body is essentially a machine and is completely equipped with appropriate mechanisms for its functional activity. In our special field, the fundamental purpose of all our efforts is to restore the normal masticatory apparatus so that normal function is possible. Some go to great efforts to adjust the jaws and the teeth mechanically, and neglect the proper development of those very parts of the machine that are most concerned with its functional proficiency.

Many fail to evaluate the importance of facial posture to the individual, as well as the important function of respiration—both essential to the well-being of the patient's physical development of his personality. Therefore, for the

orthodontist to close his mind to the larger development of his field is distinctly not a scientific approach, but an irrational one, irrational to the point of being ridiculous. The main purpose of the skeletal muscles of the face, beyond the function of mastication, is the maintenance of balance of the various parts, and when they are left neglected, as they so often are, they remain in partial disuse with atrophy and inefficiency resulting. The nicely balanced effected coordination is dependent not alone upon the functional activity, but upon the development and the conscious control through the integrity of the central nervous system. The lack of proper exercise during the period of growth, from early childhood to early maturity, frequently leads to a disproportionate development and growth of the skeletal and muscular structures with which we are concerned. Functional activity then leads to proper development and growth, and disuse leads to atrophy.

Faulty habits of facial posture demand corrective measures, and are affected only through exercises of a fair degree of severity. One of the most important benefits derived from effective exercises in conjunction with orthodontic treatment is not the development of massive muscles, but the development of a healthy vigorous condition of these structures that provide a sufficient degree of tone and vigor.

Have you ever noticed people whose personalities attract you, and tried to evaluate the sources of their attractiveness? If you have, you no doubt have noticed that their facial muscles are under control; you have noticed the confidence, ease and poise that are their reward for having well-trained facial muscles. The effect of cooperation between the mind and the muscles, particularly those of the face, enhances our abilities and promotes our advancement in social life and in usefulness. The face is made up of a number of minute muscles and nerves that, when under control, make each expression more pleasing and impressive. The face in its action, if under control with the muscles in tonic conditions, aids in our talking and in our ability to sing. Contrast such a face with the one where the nerves and muscles are atonic and sluggish to their mental responses, and you will see a face that is uninteresting and inefficient.

Orthodontists who refuse to accept their opportunity to be of service in developing such faces are undoubtedly shirking one of the most fascinating and useful opportunities when performing their daily tasks.

Consider for a moment a typical distoversion. During the progress of treatment, by whatever means employed, the maxillary and mandibular arches must first be developed to their typical size and shape. Yet when this is accomplished the relative position of the two arches is still in disharmony. By the simple willful contraction of a group of muscles these arches may be placed in correct relationship mesiodistally. By this physiologic process is seen the first approach to the permanent correct relationship where normal function is possible. Then by the exercise of another large group of masticatory muscles important, but minute, structural changes follow, and when continued to a sufficient degree, and a sufficient length of time, these minute and distributed changes have so affected the architecture of the apparatus that it is no longer possible for the subject to

assume the position of distoclusion.[9] This process has been demonstrated many times, and yet there are those who assert that the value of myofunctional therapy is open to doubt. No one who has had the opportunity and has succeeded in developing the maxillary arch by the careful use of the lingual wire on the mandibular arch, together with the employment of the groups of masseter-temporal muscles, possibly could be in doubt as to the value of such mode of treatment, nor could he longer doubt the efficacy of such treatment, or the maintenance of the development without retention on the maxillary arch.

When he has accomplished this treatment, it is easy for him to take a saner and more progressive attitude toward this enlarged service given the orthodontist through the use of these developmental agencies inherent in the individual.

It has been suggested that on this occasion I make brief reference to the inception and the evolution of the theory of myofunctional treatment.

It was because of the recognition of these elements that in 1906, in a paper[10] on "The Correction of Facial Inharmonies," read before the Northeastern Dental Association, I was led to say:

"The logical solution of our difficulties, from nature's standpoint, would consist in inducing every organ to perform the normal degree of functional activity. Would that children lived in a normal and healthy environment, for then, slowly but surely, facial inharmonies and malocclusion would become less and less prevalent.

"We must likewise resort to artificial means in order to stimulate those organs which, having been allowed to degenerate, have failed to perform their natural functions. We must bring into normal position malposed teeth, harmonize the distorted arches, and restore the facial lines to their original grace and beauty."

The first published paper upon this subject was read before the First District Dental Society of New York, December 3, 1917. This paper was prepared after years of careful study of many cases in which the idea of functional activity as an adjunct to our general treatment was employed. Unfortunately this paper was buried under a more or less ambiguous title. The First District Society of New York was at that time conducting a progressive study based upon a series of lectures which included first, "the human mouth and its surrounding tissue in a state of health"; second, "its various phases of abnormal development or diseased conditions"; third, "its restoration or its development to the normal." My responsibility was to provide a paper to cover this third phase of the progressive study, and the title, "The Development of Occlusion," which was given the paper was, more or less, in accord with the plans of the committee, and would have applied equally well to a consideration of the development of occlusion from an embryonic and physiological standpoint. During the following years many papers were prepared upon the same theme, but with slight variations for the purpose of elucidating obscure points, or in explaining further slight advances, usually under titles which emphasize the development of functional activity, or in some instances the correlation between mechanical treatment and developed function.

It was not until Dr. B. E. Lischer, who from the beginning has assisted us in developing our more modern nomenclature, suggested the present title of myofunctional therapy or myofunctional treatment that it was adopted. It seemed so apt a designation of the work I had been carrying on for years that I was happy to adopt the suggestion, and to give Dr. Lischer the credit for his valuable assistance. I have introduced this brief historical reference not for the purpose of offering an excuse for amateurish performance, but to furnish a reason why the first efforts in this important subject show evidence, perhaps, of a lack of clear and definite understanding of fundamentals. But if you will study the history of the development of the medical profession, and our own profession in particular, you will find that these deficiencies of knowledge have been characteristic, and even today, with the further advance of knowledge and the more explicit insistence upon a higher degree of education including scientific preparation, the same is true.

The search for truth is forever handicapped by insufficiency of insight and definite understanding. Yet, in spite of it, the march of progress continues, and little by little the maze of the unknown reveals new truths that place our knowledge on a surer foundation. But referring again to my earlier papers for the express purpose of satisfying the request for some historical review, I shall reaffirm the fundamental principles first laid down as a foundation for the conception that we have today of the fundamentals of myofunctional treatment as an adjunct to our understanding of orthodontics.

The following quotations from these papers[11] will give you an insight into my thoughts upon the subject during its inception:

"Even a superficial reading of the history of orthodontia will reveal to the student that, up to the present period, the followers of this specialized branch of dentistry have given more thought to the development of mechanical appliances than to the search for methods of a more fundamental character."

"The most valuable appliances are those which interfere least with the normal tendencies of development, and in their construction and adaptation are freest from interference with muscular activities and habit forming possibilities."

"Careful study of the use of these delicate appliances may save the patient long years of application and possible discomfort. Thus ridding the teeth themselves of the handicap and improving their environment."

"If we are able to select the best mechanical ideas that we now possess and learn to apply them scientifically, we have, I think, sufficient for our present needs, or at least until we perfect our knowledge of the natural forces and educate ourselves to their scientific use."

"Whatever mechanical stimulation we choose to employ, we must follow it with the development of the function of mastication through muscular development. We must encourage also the development of the respiratory function through adequate and proper exercises. In each case applying methods most suitable to the character of the maldevelopment."

"The principles that underlie normal development and normal changes of the tooth position must not be ignored or omitted from the plans of construction, or the orthodontist will in some instances interfere very seriously with the normal processes of development."

"Having then before us the principles of procedure, we are prepared to consider their practical application. The principles are: First, the mechanical re-establishment of arch form and cusp relation by the simplest mechanical means, thus removing any interference which tends to discourage the normal function of the muscles. Second, the principle of muscular balance and mechanical advantage in the complete organism, including special guidance and control of those muscles concerned in the particular weakness upon which our attention is to be directed, urging them on to their normal development and strength until the harmoniously developed face completes the restoration of the organism to its normal inheritance."

"It is obvious that well-developed muscles are more beautiful in appearance. In fact there is no comparison in facial development and symmetry between the results obtained in those cases which are treated solely by mechanical interference, and those cases which have received a due amount of attention to the development of the various groups of muscles. Beauty of the facial contour is improved. The action of the muscles themselves is more normal and harmonious, and I believe that the results are more far-reaching than the face alone. Again the retentive value of a well-developed orbicularis oris muscle must be clear to you all. Consider what it means to have the internal muscles harmonious in their activity and influence. Consider what it means to the field of our special endeavor when we know that we are frequently bringing larger quantities of fresh nutrient-laden blood to the parts."

"Malnourished children respond less quickly to treatment than those properly nourished, and the malnourished are found among all classes of people. Just here is an opportunity for cooperation. The undernourished child, who is suffering from a high degree of irritability, is an unfavorable subject for dentofacial treatment. Yet, in many instances, it is just what the child requires as a preliminary to better health. Under such circumstances the physician may frequently render the child much more receptive to treatment by prescribing a suitable diet and enforcing general rules of health and body building, greatly assisting the child and making it possible for the corrective work to be carried on with greater assurance of success.

"The orthodontist when undertaking the treatment of such individuals will be wise if he looks carefully into their environmental surroundings, making careful inquiry into the habits of life such as eating, sleeping, playing and social contacts. When a careful investigation has been made, quite frequently it will be found possible to change some of these habits, substituting for them habits of life which may tend toward the building of a finer physical constitution."

"It has long been taught and generally accepted that, after the teeth have been placed in their normal positions of occlusion, and maintained for a more or less lengthy period, retention is assured as far as that is possible. This is

far from the truth, because as already stated, unless the surrounding soft tissues are equally normal in development and action the bony structure supporting the teeth will be influenced in some undesirable direction. The muscles of the face must perform their proper function, and in order to do this they must be strengthened. Strong muscles perform their function without fatigue and accomplish an unusual amount of work without a great deal of mental effort."

"The orthodontist has handicapped himself in the past by trying to gain results solely through his own efforts instead of pointing the way to personal self-improvement by the patient, ignoring the physiological forces which work under the direction of the mind in stimulating functional activity of the various organs which are essential to his complete success."

"Harmonious action of the muscle groups concerned is quite as important a factor as their increased strength. Mechanical forces alone only partially attain wished-for results. The muscles are 'living orthodontic appliances.'"

"Development brought about by increased function needs no retentive apparatus, but development brought about by mechanical means alone must be retained mechanically until the muscular function has been well developed."

"The successful practice of orthodontia depends not only upon the treatment of teeth and bone and muscles and the skillful manipulation of appliances, but upon the psychologic knowledge of the operator and the mental condition of the patient."

"The understanding of the normal processes of nature, coupled with an intelligent and cautious reeducation of the abnormal individual, is the scientific basis upon which modern orthodontics rests."

"As a by-product in orthodontic treatment of this nature we find that there is produced a quality which is almost always lacking when treatment is undertaken purely by mechanical means, namely, the full efficiency of the function of mastication."

These are but a few of the observations made in those earlier papers, which introduced to the profession the idea of the value of functional activity and balanced muscular action as an adjunct to the treatment of malocclusion.

With a limited time at our disposal it would be unwise to continue the history of the development throughout the subsequent years. I prefer rather to discuss considerations essential to a more thorough understanding of what our beliefs and practices should be in a well-rounded system of orthodontic treatment, in which it is natural for me to place emphasis upon functional activity. At this point, however, to forestall criticism let me emphasize that this is done with the full knowledge that we recognize fundamental elements of growth and development which precede function, and without which function would be useless. Briefly stated, these elements consist of the nutritional factors of growth, including vitamin, mineral and the hormones provided by the internal glandular system, together with the psychological elements, which, although they may not have an initial influence upon growth and development, may very rightly be considered frequently to have directed influence upon architectural form. I refer, of course, to the various habits due to reflexes and nervous instability.

I have noticed a strange tendency among orthodontists, especially those who are concentrating upon some subject which has become to them all-inclusive. Let us take, for instance, the subject of the glands of internal secretion. Some of our contemporaries working in this field tend to condemn the efforts of those in other fields, thus limiting their own influence, at the same time tending to create a controversial atmosphere. This is not the true goal of science, the true goal being a sympathetic understanding of the various elements which influence growth and development with the final hope of correlation. I do not believe that I could bring myself to criticize the results of conscientious effort made by any one of our members in his chosen field of investigation. I would feel, and rightly so, that he knew more about his subject than I who had never given it serious study. I would encourage him in his investigation, and would welcome and expect the same attitude on his behalf. That the glands of internal secretion are influential in the development of bodily structure is true beyond question, and it is a subject to which the orthodontist should give his conscientious attention, for our problems will not be solved eventually until we have obtained sufficient knowledge to create balance where imbalance is manifest. But we have asymmetrical development in certain individuals which is due to other causes—causes of a nutritional character. These we must learn to evaluate and bring into our system of clinical practice. They all have a bearing upon the nervous and muscular function, and so you can clearly understand that we are all working to solve the riddle of normal growth and development, but are divided somewhat in our interests because the complete knowledge of physiological growth is a subject too great for any one mind to comprehend.

A consideration of the treatment of undesirable muscular responses, which are sometimes called reflexes, properly comes under the system of treatment which we are discussing. Orthodontists of experience all readily admit that they are frequently baffled in securing satisfactory and permanent results in the treatment of malocclusions complicated by tongue sucking, lip and cheek biting, and other reflex tongue habits, as well as thumb-sucking, pillow sucking, and pressure habits resulting from abnormal resting habits. The orthodontist finds difficulty in treating such conditions, chiefly because he either is untrained in the psychological approach or is not blessed with the natural ability to meet adequately his responsibilities.

The habit of thumb-sucking has been discussed pro and con by orthodontists and pediatricians, without as yet producing any marked improvement in the general attitude toward the subject. Experiments by Dr. David M. Levy have established the fact that thumb-sucking may be regarded as a habit induced when the child is allowed to ingest his food too quickly. Experiments were carried out on puppies, calves and chickens, showing that where the food stream was delivered slowly, and the subject was compelled to exercise the instinctive sucking response to satiety, no considerable sucking habits developed. It was explained that the pecking habit of chickens is analogous to the sucking habits in infants, and when the chickens were deprived of the opportunity to peck for their food, they pecked one another to such an extent that some were entirely denuded of feathers. In the controlled group of chickens, where they were

allowed to obtain their food naturally, no pecking habits were developed.[12] The modern supposed-science in child rearing, where the child is left alone to care for himself for long periods of time, under which circumstances his mind becomes directed upon himself, seems responsible for the development of habits of various kinds; and thumb-sucking is one of the most convenient and most persistently sought. It is, therefore, right when the subject is one of discussion that the orthodontist should advise mothers to be sure that their children have opportunity to exercise the instinctive habit of sucking to the point of satiety, even to the use of the old pacifier, which unfortunately fell into disrepute because of its unintelligent use. The correction of thumb-sucking otherwise is difficult to eradicate, in spite of the many devices which have been invented for that purpose. Not until the child has reached the age of some measure of understanding is it possible to use scientific methods for habit correction, because they are based upon understanding as an initial step. Therefore, when the child is old enough, the most approved methods of habit breaking may be instituted, the procedure being the same as that used in stammering, lip biting, tongue sucking, and fingernail biting.

It is necessary, and highly important, when observing these habitual malactions to study the habit pattern, because one of the first principles in correcting the habit, which it must not be forgotten is an unconscious reflex, is to have the patient first become conscious of the habit, and then with a careful explanation make him understand the detrimental results likely to accrue, or which already have occurred.[13] The treatment is purely a clinical matter, and each case must be analyzed as an individual one by the orthodontist. The first thing that the patient must be taught is to practice this habit consciously. The patient must understand the nature of his defect and its serious disadvantage, and he must become desirous of learning how to avoid it. The subject must be discussed with him and the situation made crystal-clear. He must understand thoroughly that his own desire is the fundamental curative agency, and that following the orthodontist's instructions meticulously is the important secondary factor. In this way, only, can the patient be put in the proper mental attitude. He must not be allowed to worry about it, but given assurance that by carefully following instructions the condition may be readjusted. It is my custom to make it clear always to parents, guardians, and others who are in contact with the patient that no notice should be given to the patient's habit, and that no attempt should be made at correction. I try to make it clear to them that repeated reference to the habit, either by word or by admonishing glances, will only react upon the patient's nervous organism and will cause the habit to become more deeply seated and more difficult of correction. I then explain to the patient that an important effort toward the cure is the daily practice of the habit before a mirror; but he should first practice the habit enthusiastically under the orthodontist's supervision. He should be led to engage in it without any inhibition and without any doubt. This is important in order to establish the proper mental attitude. The orthodontist's skill must be exerted to find the suitable wording, so that he may convey to the patient proper understanding, and arouse in him the attitude that is required. This may not be acquired in the first few

sittings, and must be continued until the patient understands the situation reasonably well. In certain other cases less time is required, but in difficult cases the orthodontist may be required to prescribe longer periods of practice. The patient, while he is learning to perform the action consciously, is, at the same time, gaining the ability to control his action. In some cases it is advisable to put the tongue or lips through a system of gymnastics, which, after a few weeks' practice, will render the offending member more easily controlled.

It is natural, when considering myofunctional treatment for the correction of malocclusion, that the subject of malnutrition should be considered as definitely belonging to this phase of treatment, the reason being that the well-nourished child presents a very different orthodontic picture from the ill-nourished child. Emphasis should be laid upon the fact that the well-nourished child's muscular system is a tonic muscular system, and it reacts to more normal nerve impulses. The circulation of the blood is more active, and the functional responses are more definite, and in their normal reaction keep creating a tendency toward normality of structural form, resisting the influences of the abnormal reflexes which we have discussed in the section on habit and its correction. It is, therefore, important that the orthodontist give more attention to the study of nutritional deficiencies. While thus far his training does not qualify him to prescribe diets indiscriminately, because this can be safely done only by the skilled physician who has at his command every facility to determine the nutritional requirements of the individual child, the orthodontist even in view of this fact should be competent to diagnose malnutrition as he meets it among his patients; and, when he does, he should have the forethought to refer the child to a competent physician for a thorough scientific examination and treatment. His full duty as an orthodontist is not performed unless he so conducts himself. If you will visualize some of the patients in your individual practices, you will be impressed with the frequency of malnutrition in the more severe types of malarrangements of the dental organs and the arrested development of the investing tissues. In fact, it is becoming my belief that in certain types of malocclusion, before orthodontic measures are undertaken, malnutrition should be corrected as far as it is possible. This not only is true in relation to our efforts with orthodontic appliances, but it is true also in our efforts to establish correct muscular responses, and a balanced function of the various groups of muscles with which we are concerned. If there is any message which I bring you which needs special emphasis, it is this one; and in order to impress you more strongly I am going to read you quotations from the writings of Dr. Lydia J. Roberts, who is an authority on the nutritional work of children. As I have said in former papers, malnutrition is not confined to children of the less fortunate but is found among all classes of society, because it is a matter of vitamin and mineral deficiency, and in some cases due to the derangement of the harmonious action of the endocrine glands. Dr. Roberts[14] describes a well-nourished child in the following words:

"The well-nourished child has a well-developed body, with firm muscles and subcutaneous fat to form a moderate padding over the bones and muscles.

His skin has a healthy glow; the mucous membranes of the eyelids and the mouth are a reddish pink, and the hair is smooth and glossy. His eyes are bright and clear; there are no blue or black circles underneath them, and his usual facial expression is bright and unworried even in repose. His posture is generally good, with the head erect, chest up, and the step elastic. In disposition he is usually happy and good-natured, and he is full of life and activity. His sleep is sound, his digestion good, his bowels regular. He is, in short, what nature meant him to be before anything else—a happy healthy animal."

A competent orthodontist should be an observant individual, and the focus of his interest should not be upon the maldeveloped arches alone. The fact that our vision is so often circumscribed explains the cause of many of our failures, and it also explains the cause of many of our misjudgments, especially when we, as some of us on occasion do, assert that maldevelopments are self-correcting. It is my belief that we will be more apt to find them self-correcting among those types of children which exemplify the well-nourished child whose description you have just heard. In order to solicit your interest further in this phase of our endeavor, I would give you the description of the malnourished child as Dr. Roberts so clearly expresses:

"The malnourished child, on the other hand, lacks several or all of these characteristics of the normal child, depending upon the degree of malnutrition. He is usually thin, but may be fat and flabby instead. His skin may have a pale, delicate wax-like look, or it may be sallow, muddy, or even pasty or 'earthy' in appearance. There are usually dark hollows or blue circles underneath the eyes, and the mucous membranes inside the eyelids and mouth are often pale and colorless. His hair may be rough, like that often seen on farm animals that are poorly cared for, his tongue may be coated, and his bowels constipated. His skin seems loose, his flesh flabby, and his muscles underdeveloped. Because of a lack of muscular tone his shoulders are usually rounded; sometimes the shoulder blades protrude to such an extent as to produce the deformity known as 'wings.' His chest is flat and narrow, his abdomen protruding, his arches may be flat, and his whole attitude one of drooping fatigue. In one type of malnourished child the animal spirits natural to all healthy young will be lacking. Such a one will be listless in play, not caring to romp and run like other children. He will probably be regarded as lazy. There is apt to be a lack of mental vigor also; little power of concentration and attention and absence of a child's natural alertness are common characteristics."

There is much more that might be said regarding the appearance of malnutrition among children, but I have given enough to paint the picture that I hope will cause each one to be more observant, and more concerned regarding the nutritional status of his patients. I should like to emphasize the fact that orthodontists should be concerned with the application of appliances only as a means of correcting certain defects, and that behind and beyond *all* that the orthodontist may do are those important phases of growth and development in childhood dependent upon the vitamin intake, the harmonious and coordinate action between the endocrine glands, and the ingestion of the adequate minerals to supply the organism with the material for normal growth.

The foregoing I consider *basic* in the treatment of all types of malocclusion which we are called upon to treat. I have learned from my own experience that that type of individual answering to the description of the malnourished child is that type with which we have our greatest difficulty, whether we believe in the employment of myofunctional treatment or not. And I have no hesitancy in asserting that the well-nourished child possesses a system of living orthodontic appliances that are active in maintaining a tendency toward the development of normal form, as a part of the general system of growth forces; and that the malnourished child is endowed with a system of living orthodontic appliances which are inadequate in their performance, and are failing to assist in the general development of structural form along with the deficiency of vitamin and mineral constituents together with imbalance in the endocrine system.

It is impossible in a single paper to carry these important matters to greater length, but I will feel rewarded if this effort succeeds in bringing to your minds the utter importance, the utter necessity of orthodontists giving more attention and greater consideration to them.

I am as well aware as anyone, I think, of the fact that the matter of vitamins, as well as the matter of endocrine consideration, is a subject for experts and not for the charlatan; and for that very reason I urge the profession of orthodontics to seek the most skillful and most scientific approach to this subject, and place their patients in the hands of only the most competent. The whole problem of dental and facial development, if we are ever to eradicate the scourge, must depend upon the harmonious biochemical reactions within the organism itself. When we approach the subject in this manner, we shall become really scientific; and, unless we do, we must forever remain as mechanical repairers of damaged organisms. There is much more that I should like to add to this subject. The temptation is great to prolong its discussion, but I am going to satisfy myself by drawing only one simple analogy. Those of you who have been interested in horticultural subjects have learned to realize the importance of soil, of sunshine and rain to the welfare of plant life. You have probably experimented with fertilizers of various types, and you have learned that in the absence of one single element your plant will not grow to the limit of its possibilities. You have also learned, by the application of a single mineral substance, that by its reaction nutritional values may be liberated from the fertilization elements, and produce a stimulation of growth which otherwise might not have occurred. The child is analogous to a plant. The nutritional elements, the mineral substances, and the hormones produced by the glands of internal secretion, all, must be furnished adequately that a balanced reaction may take place. And because of the realization of these elemental facts of nature, I am becoming more and more of the opinion that the prevention of malocclusion, the proper development of the bony framework of the body, and the harmonious and form-directing function of the muscles form the basis of the normal development of the individual. If I am correct in this supposition, I can look forward to the day when the correction of malocclusion, or perhaps I might better say the prevention of malocclusion, will not remain in the hands of the mechanical orthodontist, but will be successfully undertaken by those who under-

stand the methods of scientific diagnosis and the efficient application of the science of nutrition. As a profession, we shall prove ourselves unselfish if we seek to promote the dawning of that day.

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PLACE OF THE LINGUAL ARCH IN ORTHODONTIC THERAPY

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AS WE make new and inspiring advances in the science and art of orthodontics, we should never tire of giving credit and praise to the stalwart pioneers in our field. We are the beneficiaries of their manifold efforts. Only a few decades ago, there was little of science or even of reliable theory in orthodontics, and much less of art and of dependable achievement. The advances have come step by step. Today we have an art based on a science which is becoming more and more accurate. It is an art which is recognized by the professions and the public as an important contribution toward the health and comfort of humanity. Let us give tribute to the pioneers who made our present success possible.

Of course, we all acknowledge with pride and admiration the outstanding work done by Dr. Lloyd S. Lourie and Dr. John V. Mershon. Nor do we forget the pioneer work which Bonwill, Farrar, Jackson, and many others did on the lingual arch and on a host of other important phases of orthodontics. They were the leaders who, not satisfied with what the profession then had, pushed forward to new achievements. It is an experience of life at its fullest to see them, and now to see others of our group who possess divine discontent, strive until they break down barriers and carry us all forward with them. These men merit our recognition of their leadership. Let us, like them, be discontented with what we now have. Let us not be satisfied. An eminent surgeon once said, "When men smile and agree, progress weeps." But when men disagree and still smile, as they do in our Association, and then think and plan to find and overcome the causes of their disagreement, then truly there is every reason why progress should be made without limit.

Orthodontics, new as it is, has made more rapid progress than any other branch of dentistry. Not every new idea, of course, represents genuine progress. Occasionally a new idea is presented which for a time seems likely to influence greatly our methods of practice, but after a little while it proves unimportant or a downright mistake. We are not even free from mere fads. But real progress also comes. Sometimes it is slow; the advance made is at first hardly perceptible, and it proceeds by almost invisible steps; but it is really an advance. The membership of our profession has always been receptive to suggestions; new ideas are welcomed and then experimented with, thereby adding zest and interest to our endeavor to give a more adequate service to our clientele.

As in every other field of science, each advance we make brings out more critical study, investigation, and experimentation touching what we had before, as well as the new thing. One definite point of progress to be noted is that we

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now realize our ignorance of many of the questions upon which we felt fully informed twenty years ago. Let us sincerely hope that this is one of the growing pains of a much greater wisdom—a wisdom of the future which will not be at all satisfied with what we think of as established facts. May we never build a wall about ourselves to keep out better ways to serve our day and generation more effectively. Rather, let us strive without ceasing. Let us not only improve our technical abilities, but also learn how to remedy the causes which, if unchecked, later make our technical services necessary.

In discussing the place of the lingual arch in orthodontic therapy, I am deeply grateful for the privilege of bringing to you again one type of treatment which holds an important place in orthodontic therapy—a place which, many of us feel, it has gained by proved practice, critical experimentation, and exhaustive application.

It is not desirable to make unlimited claims for the lingual arch. Those of us who have used it, in its many diversified forms, for more than twenty years would hardly claim that it will accomplish everything, or that what we have now is the final stage of its development. We expect, and have constantly been alert for, something more applicable, more effective, and more dependable. We have, and have always had, an open mind. We do not consider that we have a Utopian gift which does all things perfectly. The lingual arch is used in many, many ways. Some enthusiastic advocates claim more uses for it than others do, and perhaps these claim too many; but not even the most enthusiastic of us believes the lingual arch to be an unlimited universal appliance. We well realize its inability, or at least its present inability, to accomplish all that we desire of the ideal appliance in orthodontic therapy. We do, however, believe that, as things stand now, it can do and does do safely, physiologically, and comfortably, when it is properly used in trained, experienced hands, more than any other appliance is at present dependably capable of accomplishing. It is not my intention to criticize unfavorably any other type of appliance or any method of application of orthodontic therapy. In advocating the lingual arch I should be glad to be not destructively critical of other appliances or methods, or of their originators or adherents.

May we glance first at the history of the lingual arch? The appliance, as employed and indicated today, is not a new thing in orthodontics. It did not come into being or use until, in years past, a considerable number of workers in dentistry and orthodontics had worked with it and through it. Many of these pioneer workers did original work, so far as they knew, quite uninfluenced by each other. Probably a good many dentists employed some form of the lingual arch before a later orthodontist, from whom we have reports, began the recorded utilization of this appliance in orthodontic therapy. The lingual arch is not new to orthodontics. No doubt more progress, improvement, and refinement has been given it in the last three decades than in previous history, but it has long been used both as a regulating and as a retaining appliance.

In the nineteenth century the appliance was used both as a fixed and as a removable arch, employed to regulate and to retain, even as we use it today.

In his important book, *Irregularities of the Teeth and Their Correction,* John Nutting Farrar, M.D., D.D.S., included, in the year 1888, many illustrations and explicit directions for making and using the fixed and the removable lingual arch, as well as for employing many other types of bands, appliances, and fundamental principles which are daily employed in present-day orthodontics.

Some amount of misunderstanding and confusion has occurred regarding giving credit where credit is due relative to the priority and original claims of dentists who early employed the lingual arch as used today. Dr. Lloyd S. Lourie, of Chicago, successful student, orthodontist, and teacher, used the lingual arch both as a removable and as a fixed appliance in 1903. But he did not then receive published recognition. Because we who have come along in the last twenty-five years have had to depend for information largely on the literature and the proceedings of our meetings, we have not given to Dr. Lourie the credit he deserves. The reports of Dr. Lourie's work were sent by him to Dr. Edward H. Angle for publication, but were not published. Afterward, Dr. Martin Dewey wrote his impressions of Lourie's work with the lingual arch, but these reports were not entirely accurate as to the actual manner in which, and the time when, Dr. Lourie first employed both the removable and the fixed lingual arch. The original notes regarding Lourie's clinics and reports were sent, years later, to Dr. Herbert A. Pullen, when he requested them for inclusion in the chapter on orthodontics appearing in *Johnson's Operative Dentistry,* Fourth Edition, which was published in 1923. Extensive scientific articles and clinics by Lourie over a period of years also never clarified exactly when and what his original work with the lingual arch actually was. Recognition has consequently been withheld from him.

Neither Dr. Lloyd S. Lourie nor Dr. John V. Mershon claimed to have discovered the lingual arch; it had been used and recorded for a long time before them. But there is a difference from the employment before them in their use of the appliance that makes a rather new departure.

Both men reported with reserve their employment of the arch. Their modesty and scrupulousness in studying and investigating the possibilities of the lingual arch before rushing into print set an example and ideal which all of our generation would do well to emulate.

After Dr. Mershon had had nineteen years of successful general practice in dentistry, he graduated, in 1908, from the Angle School of Orthodontia. Always a good student and an original thinker, he conceived the idea of the advantages of the removable lingual arch and continued his work on this appliance until he had developed the round vertical tubes on the lingual of the molar bands. Finally, to prevent rotation of the molars, he developed the half-round tube he is using today. Beginning with conforming the lingual arch to all the irregularities of the teeth, then in turn straightening out some of the curves and replacing the lingual arch, he evolved the plan of soldering an extra piece of wire to the lingual arch, and this was the inception of the present-day auxiliary spring as he uses it. Besides his contributions in this connection to the science of orthodontics, Mershon has been such a leader in many other developments of our specialty that he is endeared to us all.

Dewey, McCoy, Eby, Howard, Bach, Porter, Arnold, Irish, Wood, myself, and many others have continued the elaborations, improvements, and refinements on the lingual arch until today its advantages and indications are appreciated by orthodontists everywhere.

When the science of orthodontics comes to its fullest usefulness, and the knowledge of its many phases is completely comprehended and utilized, the crowning appliance will be, not a universal appliance, but an ideal appliance of limited scope, but fully capable of doing the definite thing it is intended to do —that is, produce physiological activity. Please do not, however, interpret this expression to mean that appliances are to be the answer to all orthodontic problems. The movement of malposed teeth into what appears to be their normal functional line of occlusion without regard to tissue change is certainly not the principal undertaking of orthodontics. This fact has been discovered by some dentists to their sorrow. The large variety of malocclusions and of facial deformities which we are expected to treat present many more complex problems than can be solved by employment of a universal appliance. There must be variety and invention of resources. Every case is an individual problem, and orthodontic therapy can no more be standardized than can the number of stars in the heavens be counted dependably the same. Our problems are complex and manifold. Appliances are simple and limited in scope. We need to remind ourselves continuously that orthodontic appliances can do only two things at best: push and pull. Dentists who employ the lingual arch when indicated believe that the simpler the appliance the more satisfactory, comfortable, hygienic, and dependable the treatment. But the problem of complete service to the patient may be anything but simple.

It must be distinctly understood that in discussing an appliance useful in orthodontic therapy, I do not minimize the vast importance of the biologic and physiologic problems which lie at the heart of our specialty.

While we are fully cognizant that the ideal appliance does not now exist, we can probably agree that an accurate standard of excellence has been set by Eby when he says, "In the ideal appliance must be found:

"1. Stability of attachment. Inability of patient to remove appliance.

"2. Greater resistance or a countercontrol of resistance in the anchor regions against the sections of active movement.

"3. Ability to control the teeth on individual paths of movement toward the normal, unless segments of arches may be similarly controlled collectively.

"4. Susceptibility to reasonable alteration to meet advancing developments, although the delicacy or difficulty of construction should not be the primary consideration.

"5. A mild pressure producing a stimulation of the osteoclast, which cannot be sufficient to affect the pericemental circulation or to bend bone or produce pain.

"6. Adjustability in tightening, so that the exact degree of activity can be measured and controlled at regular tightening intervals.

"7. A pressure so constant as to establish and maintain a uniform activity in the cells and to prevent the shocks which occur with intermittent forces.

"8. Elimination of all forms of leverage such as produced by a one point of contact pressure against the crown of a tooth, to eliminate tipping of the teeth with no apical movement, which is required in the greater percentage of appliances.

"9. An attachment which can produce bodily root movement in any direction required.

"10. Cleanliness, freedom of contact against the soft tissues and injury to the enamel.

"11. To subserve, partially at least, for preliminary advantages, the correct principles of retention.

"12. To be free from bulkiness and be inconspicuous."

In discussing the bad features and the limitations of appliances, one must remember that appliances are mechanical devices for exerting pressure on malposed teeth, and thereby influencing cell metabolism with a view of causing the teeth to assume their correct relationship.

Mershon defines functional relationship in this way: "While we are moving the teeth from their positions of malocclusion to normal functional relations, the tissues surrounding and supporting the teeth will so adapt and adjust themselves through an interaction of forces, that the proper equilibrium between teeth and tissues is maintained during the whole process of tooth movement." Going further, he says: "Appliances are effective in proportion as they apply force in the direction of normal growth, and in so doing, do not interfere with the function of any of the tissues associated with the teeth, or with the teeth themselves collectively or individually; each tooth being free to functionate normally."

An appliance in conformity with absolute harmony between normal growth and the stimulation of the supporting tissues would be ideal; but as yet there is no ideal appliance. All types of appliances thus far devised have some admittedly bad features, and successful orthodontics is not altogether due to the appliances employed. Orthodontics depending entirely on the appliances often comes to grief in its ultimate results.

In the past, orthodontics consisted chiefly or wholly of aligning irregular teeth. We are now, however, as a major function of our art, treating oral deformities which partially or wholly interfere with normal function. In the past, the object in view was to push or pull teeth into position in the quickest way, with little or no thought of the ultimate physiological result. We understand now that a mechanical device cannot even make an absolutely perfect normal occlusion. The individual size and shape of the teeth and the gradual growth of the associated oral structures play such an important part that they must be dealt with far more complexly than once seemed indicated. No appliance, working alone, can accomplish the ultimate good we nowadays seek. An appliance, even if ideal, will be only a stimulus to the supporting tissues of the tooth exerted by means of pressure applied to the tooth. It will work in conjunction with the natural stimulus of growth going on in these tissues. The dental arch, as a part of the individual, grows with the individual; and the

stimulus of the appliance and that of natural growth must be reconciled, the appliance being the adjustable factor which can be manipulated so as to exert control over the growth occurring in the tissue.

The rapidity of the work of the appliance must also be limited, as the teeth must not be moved faster than normal growth change permits. Normal growth, if given a chance, will usually accept a part of the burden of developing normal occlusion.

Referring to our definition of an ideal appliance, we find that it must first exert pressure on the malposed tooth; second, it must alter cell metabolism, and only as a result of the first and second, can the third be accomplished. Third, it should cause the teeth to assume their proper position and relation. If only one of these three requirements existed, there would naturally be less liability for bad features to arise. We find that the environment in which the appliance is to be used tends to develop bad features. The appliance must be able to withstand much abuse arising as a result of mastication and use of the brush.

It must be remembered that the amount of space available for the application of the appliances is sometimes detrimental to the construction and design of the appliances. The space in the oral cavity is necessarily limited, and the lips and tongue will not tolerate bulky devices.

The first feature of appliances to be considered is that in all designs built along the lines of efficiency, the appliance, in order to be a success, must be constructed according to standard mechanical principles. But the question of efficiency is influenced by conditions which we have already mentioned, and which now must be related to another feature, that is, the stability of attachment. Many efficient appliances have been rendered useless because of insecure attachment to the anchor teeth and improper relation to the malposed teeth.

The maintenance of stability must be noted as one of the troublesome features of appliances and one that possesses certain limitations. To it a large portion of the unsatisfactory results sometimes arising from orthodontic treatment can be attributed. The stability of attachment must be recognized from two points of view—the attachment to the anchor teeth and the attachment to the malposed teeth. The attachment of the anchor teeth, or the anchorage, will always be a problem, because an ideal anchorage has not yet been secured inside the oral cavity. The majority of anchorages employed are obviously unstable, as any given tooth or teeth are always slightly movable; such a thing as perfect anchorage has not been found. Recognizing this as a weakness in the beginning, we shall achieve greater success if our appliances are designed with this in mind. If we recognize this undesirable feature at once, all limitations can be more or less satisfactorily solved by utilizing the strongest available structures at the beginning, and designing the appliance so as to favor such anatomical structures as are present.

Another problem of anchorage is the fact that the slightest amount of pressure exerted upon the teeth, if continued sufficiently long, will result in tissue change, which will allow the teeth to move as a result of that pressure. The teeth employed as anchorage will be influenced, as well as those intended to be moved.

Another phase of instability of appliances is the often unsuccessful attachment of devices on the malposed teeth. This one feature has resulted in the failure of many otherwise satisfactory appliances. We have seen it fail because of insecure attachment to the malposed teeth. Such a statement can also be made in regard to the alignment wire when used with wire ligatures, or in regard to auxiliary springs not properly secured to the malposed teeth.

Many men have recognized these undesirable features in appliances and have centered every attention upon some method of securing the appliance to the malposed teeth, with the result that the attachment has become so rigid as to absorb the exerted force on the malposed teeth, and offer sufficient resistance to produce a movement of the anchor teeth. The remedy thus creates a new evil, perhaps as great as the one it cures.

The very nature of malocclusion is such that when the appliance rests on or touches the malposed teeth, it must be in such a manner as to allow all the functions of mastication to be performed. This is a physiologic requirement that should not be overlooked, and likewise it is, unfortunately, one that can hardly be lived up to with the modern appliance. In other words, every one knows that it is necessary for the teeth to function properly, and this very thing is liable to result in insecure attachment; so it then becomes necessary to select the lesser of the two evils, depending on the type of malocclusion which has to be treated. Opposed to the appliance is the stress from mastication which cannot be done away with, although as this stress is infrequent and that of the appliance continuous, the appliance is the controlling stimulus.

We have been noting the problems of maintaining proper stability of the lingual arch. Another important factor in appliances is the material which we are using in their construction. That the materials we now have are not wholly satisfactory is proved by the fact that the orthodontists of today are not united in favoring any one material.

The quesion of a proper band always involves three factors: the expense of the material, the working qualities, and the degree to which the material stands up under mastication. The band material best suited to the type of appliances used should be selected with the greatest care, and the life of the appliance depends upon having substantial, well-fitting bands. Band material may also be selected because a certain kind of appliance is to be employed. Some orthodontists do not like iridioplatinum because of its stiffness and difficulty of manipulation, and several men of acknowledged leadership in orthodontics are now using a gold alloy for bands.

This alloy, when used for finger springs, is satisfactory, because the removable lingual appliance does not exert the same strain on the band as does the pinched wire. The gold alloy, when used for bands, can be more easily adapted to the teeth; but this last quality is considered objectionable by some men, because any band material that can be easily burnished and fitted to the teeth will be just as easily bent, stretched, and torn as a result of mastication.

Another limitation of appliances is found in the disadvantages current with the materials manufactured for their construction. The orthodontists have

been compelled to use the materials supplied, and have not been united in regard to qualities these materials should possess. It has been found that a certain alloy prepared according to one technique will be satisfactory, but if prepared differently it will be a failure. Therefore, the limitation of appliances in regard to materials is governed to some extent by the technique used in alloying the materials. An ideal material is not yet at hand.

The present paper has stated some of the general facts regarding the lingual arch.

As an advocate of the lingual arch in combination with the labial arch, auxiliary and finger springs, I feel that I have in my practice shown my faith in and demonstrated some of the possibilities and points of efficiency of this appliance. The use of the lingual arch is different in many respects from that of other appliances employed in retention and regulation in orthodontics. The utilization of this important adjunct in orthodontic therapy has successfully passed the experimental stage, and many of us believe that the correct use of these appliances will be of notable benefit to every orthodontist and his patients. Advantages, in comparison with some other orthodontic appliances, can easily be shown, and those who are familiar with the type of appliance which necessitates the banding of a large number of teeth or the essential construction of complicated and conspicuous mechanical attachments should welcome and should carefully try this much simpler and less noticeable appliance. The lingual arch, if properly constructed, is one that exerts force upon the teeth in such a way as to cause no pain and very little inconvenience. If pain is caused in using this appliance, it is usually a sure sign of improper construction or a fault in technique or wrong application of force. While this appliance possesses great possibilities, one should not infer that it is foolproof or that it can be handled satisfactorily by the uninformed or careless operator. The technique for the proper use of the lingual arch in combination can be mastered by the average orthodontist who can and will understand the fundamentals and earnestly apply himself. There are many unsolved problems. There are such in our whole field. It is as true in orthodontics as in life that we fail to agree on many matters of mutual interest and endeavor. Regarding appliances there is a distinct disagreement between those of us who prefer to use precious metals and those who insist upon using stainless steel; between the insistence upon soldered joints and upon spot-welded areas; regarding the material for and type of bands for anchorage; and regarding the half-round tubes and post. All these are still problems; but they are nevertheless not essential considerations to limit satisfaction in using the lingual arch. Careful experimentation with the arch is earnestly invited.

The success of any orthodontic appliance is dependent upon its correct use in accordance with the particular purposes for which it was designed. Appliances are advocated because they have proved very successful in the hands of those who have studied and developed them; yet when indifferently tried by others these same appliances have failed. The reasons are many: first, they are not understood; second, they are thought to be simple, foolproof; third, they are changed and modified by supposed improvements which absolutely defeat the good purposes for which the appliances were actually designed.

Orthodontists are often placed in a false light before the dental profession and the public. We are expected to live up to a great deal; possibly we have claimed too much, promised too extravagantly. Orthodontists themselves, however, sometimes belittle the specialty. They, or some of them, too often assume the attitude that a fair knowledge of anatomy and function of the dental arch and its investing structures, added to a few laws of mechanics, is sufficient to qualify one for the complete practice of orthodontics. But let it be remembered that we orthodontists are no longer correctors by force of dental deformities. We now are scientific men and women, utilizing our knowledge of dentistry and the basic sciences, metabolism, nutrition, plus our knowledge of the preservation and the functional adaptation of bone and correlated structures. May I suggest that we become better students, that we be more charitable toward each other and toward our dental colleagues. It is so easy to point out a man's failings, to criticize unjustly, but so difficult to replace our fault-finding with something materially better of our own. Let us study more, and speak less. Criticism is often cheap, yet sounds wise. Humanity seems prone to believe an attractive falsehood in lieu of the simple, plain truth. But let us seek the truth and be satisfied only with the truth. Science and the health services are not for the few. They are not to be sold at the highest price, or patented and commercialized. We are all obligated by our training and profession to be public servants; we are responsibly protected by the laws of God and by our commonwealth. We must give our most and best.

The lingual arch has a definite, undeniable, tested, and proved place in orthodontic therapy. As the smiling faces of boys and girls come and go, year after year, we sincerely believe that this appliance has merited the place which it has won and now holds. It is not a new appliance; it is not a perfected, universal appliance; but without fear of successful contradiction, I believe that its advantages far outweigh its disadvantages, that it not only compares most favorably with any other mode of orthodontic therapy today, but actually excels. May I close by quoting the sentiment of an inspiring writer, and urge each of you to greater effort and grander heights of service and satisfaction in the wonderful opportunities we daily have.

"To do the right thing at the right time; to do something better than it was ever done before; to eliminate error; to know both sides of the question; to be courteous; to be an example; to work for the love of the work; to anticipate requirements; to develop resources; to recognize no impediments; to master circumstances; to act from reason rather than rule; to be satisfied with nothing short of perfection."

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MEDICAL ARTS BUILDING

WHY DO WE HAVE ORTHODONTIC FAILURES?

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IN ORDER to recognize failure one must know what success is. A friend of mine says that he has had many disappointments in his practice but never a failure. This sounds, at the outset, like whistling in the dark to keep up your courage, but on the other hand it seems to me to be just the attitude of a man who is eternally trying, and who learns something from each of his defeats. So may all your failures be simply defeats that will spur you onward to success.

Someone has said that a case is successfully treated if it continues to improve after the removal of appliances has taken place, showing that real balance has been attained not only in occlusion but in all the vital forces necessary to the development of a normal denture. If this is success, then failure must be that result in which one does not attain this degree of perfection.

To begin with, one should have a fairly clear conception of what a normal denture is. Remember that the orthodontist cannot expect to achieve an ideal occlusion in all his cases, but he should endeavor to get at least an average functional normal. Beauty in a denture and in a face is difficult to reduce to a mathematical formula, and that which pleases one may displease another; but let us say that we should strive for an artistic arrangement of the anterior teeth with improvement in the profile to please the patient, and for functional occlusion with good bony support to satisfy the orthodontist. We may have success or failure in either or both these attempts.

The reasons for failure are legion, and I can hope only to outline some of them in a logical manner in order that we may be reminded of many things we know well, yet do not heed.

Let us first consider those reasons that lie with the patient. Here we find the condition that to me seems to be one of the greatest causes of our defeats: in cases of double protraction the loss of the mesiodistal diameter of the deciduous teeth through caries or loss of the entire tooth through accident. Of course most of these cases are also complicated with faulty metabolism or other systemic factors such as disharmony in the secretions of the ductless glands, et cetera. Then there may be disharmony in tooth form and dimensions, or teeth may be congenitally missing or even ankylosed. These cases many times present a pitiful appearance, and in order that the mother may not feel badly many of us are apt to be too optimistic in our prognosis and possibly make statements that can never come true. Then the patient and the parent lose confidence in the orthodontist, and with confidence gone, away goes cooperation, and another defeat stares him in the face. Lack of cooperation may come from other sources as well as from lost confidence, but the end result is the same—failure. You know, and I know, so many cases of intractable youngsters, of parents who wash

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their hands of the case entirely even in the matter of seeing that John or Mary keeps his or her appointment, of patients whom one just hates to see come in the office because of the lack of harmony between the orthodontist and the patient.

These are but a few of the things wherein the cause for failure lies with the patient, but is the orthodontist without blame or can some of the failures be laid at his door? They surely can. And right here is where meetings such as this do so much good—a little pep talk, some age-old knowledge in a new dress, and maybe some new facts, at least new to you, will send you home with a determination to correct some of your own bad habits as well as the malocclusions in your practice.

If our diagnosis is incorrect, of course we are off to a bad start; for it is not often possible to make a second mistake, say, for instance, in treatment planning, that sets things right. In other words, two wrongs do not often make a right.

Then there is the matter of giving sufficient time to case analysis. We are all human and have to live, and the tendency is to try to speed up the starting of a case in order to please the patient as well as to swell the bank account. We should also be sure to recognize and eliminate causative factors that will interfere with the successful culmination of treatment, such as poor diets with lack of sufficient vitamin D, systemic conditions needing the cooperation of a physician, or physical habits such as sleeping positions, posture or the sucking habits; especially those cute little rascals who start out by sucking a thumb or finger and progress to the tongue, cheek, or lip. Unless they stop of themselves or because we create a condition or arrangement in the mouth that robs the act of its pleasure, we are doomed to failure. And the swallowing habits: The poor little patients have no idea but that everybody swallows with their tongue between their teeth, and they promise never to do so again and really mean it, *but* habit is surely a hard taskmaster, and all of us know that the bad habits are the easiest ones to establish, for such is human nature. Do not make the mistake of not mentioning these habits at the time of the examination, or the parents will think you are just looking for an alibi when Sally's teeth start protruding again just because it is so comforting to her to put her thumb in her mouth when she is tired or trying to go to sleep.

On the other hand, do you know your anatomy? Would not a little review be a good thing? Do you use all the helps now afforded in diagnosis, such as standardized photographs, gnathostatic models, x-ray pictures, et cetera? Do you plan your treatment so as to take advantage of the bone already present and keep teeth in the alveolar channel during mesiodistal movements instead of first expanding and then trying to move them with the buccal roots in the dense cortical bone? Do you do your work in a logical easy manner? If you do, you are making treatment easier for your patients and success almost certain, for such procedure begets the confidence and cooperation of your patient, without which you will have really to work to obtain an acceptable result.

Then, if your diagnosis is good, how about your treatment? Do you give enough time to the proper analysis of the appliance action and the reaction

forces? Be sure it is doing what you want it to do and think it *is* doing. Do not crowd yourself too much in the matter of appointments. One of the most valuable things to remember is that five minutes more spent at the right time may save many minutes later on. Of course, some of us might be just plain lazy, but I shall not mention it here.

One may run into a snag in attempting a so-called short-cut treatment in order to satisfy and appease the patient or parent or for financial reasons. These instances almost always turn out other than the way you had hoped they would because the patient never had a real desire for straight teeth anyhow, but was just keeping up with the Joneses; hence there was no cooperation and little chance of real success.

Last, and I am tempted to say least, comes the reason that lies with the appliance. For though a perfect universally applicable appliance has not yet been designed, I believe that if we secure sufficient anchorage necessary to eliminate or distribute the effect of the reaction forces, we shall have fewer disappointments and less cause to cross the street when we see one of our old patients coming toward us.

After the orthodontist has diagnosed, planned the treatment, made and placed the appliances, checked up on the diet, general health habits et cetera, it is true that from then on he will find out just how well he has put over his story. Will Johnny brush his teeth three times every day or just the day of his visit to the office? Will Mary wear the elastics as directed or ask the elevator girl to help her put them on as she comes up for her appointment? In other words, have you that intangible something that will make your patients look forward to a word of approval and commendation for instructions well carried out? If you have, you will have success when another would have failure, and furthermore you will get a lot of pleasure and satisfaction from your work. We cannot all have this character in the same measure, but if we have but a little sprig of it and cultivate and nourish it with thoughtfulness and real concern for our patients' welfare, it will flourish, grow, and bear fruit beyond our wildest dreams.

In summarizing the causes of failure you will notice that there are unquestionably more variable causative factors on the side of the orthodontist when he accepts a case for treatment than on the patient's side. Also, in most cases the patients come to you because of the desire for a better dental apparatus and better appearance than nature had provided. They want this primarily because it will give them more confidence in themselves and faith in their ability to take their rightful place in the scheme of things without the handicap of a misshapen face and crooked teeth. Do not let them down.

WHY DO WE HAVE ORTHODONTIC FAILURES?

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THE science of orthodontics is too vast in its scope for any one orthodontist to be able to comprehend and coordinate all the factors involved in the development of the jaws and face. The physiological, chemical, and nervous factors involved in each individual's metabolic processes are extremely complicated. Combined with these are certain inherited influences which are very difficult to evaluate.

Each case, by virtue of the fact that there is a malocclusion of the teeth and jaws, is a problem in itself and does involve some disturbance or imbalance in these metabolic processes. Grant for the moment that it may be possible completely to comprehend and coordinate these intrinsic factors as they pertain to any individual case. The orthodontist's problem is still further complicated by the fact that each case is subjected to many extrinsic influences as well. The parents, one or both, and possibly we might include the nurse or governess, the family dentist, and the family physician, each has some influence on the case which presents itself for treatment.

The physical development of an individual is predestined, by the laws of inheritance, to follow more or less definite lines which are extremely hard to determine in a people of such a mixture of racial types as is the American people. The orthodontist is called upon to determine, on the basis of evidence presented by an immature person, his probable future stature, the size and shape that the face will assume, the eventual size, contour and number of the teeth. In short, he should be able to predict what form nature intended those jaws and teeth and that face to take. Many other factors must enter into his consideration before that decision is made.

The first question that arises is, what were the causes that brought about this undeveloped face and these deformed jaws? The conditions in the mouth reflect the general state of an individual's health. Malposed and decayed teeth, gingivitis and deformed jaws are evidences of imbalances in the biochemical processes of metabolism. If the source of the imbalance can be recognized, the next question is, can it be removed? If so, the orthodontist's job is somewhat simplified. But in so many cases the organic or systemic cause of these dental defects cannot be ferreted out. The orthodontist then must struggle along in the face of this handicap, overcoming it by mere persistence.

Let us for a moment consider two or three general types with which we are all familiar. First, there is the small, frail, pinched-faced child of nine years who looks as though he never ate enough food and could not assimilate what little he did eat. Eating little, his mastication is almost nil, his teeth show no facets of wear, his arches are small and the teeth crowded. His whole

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anatomy seems crowded into too little space; he is subnormal physically but mentally unusually alert and keen. How do we coordinate the picture? "The nervous type," we say. But why is he the nervous type? From the parental physical standpoint his inheritance is good. We look into his home: one of the very best. Everything the heart can wish: a nurse or governess to see that he gets his proper food, that he goes to bed at regular hours, that he gets up in the morning, and that the chauffeur gets him to his private school on time and before he gets his clothes and hands dirty. He is called for and brought home to a lunch of the daintiest, tenderest morsels of food. All the vitamins, the organic salts, the proteins, and the carbohydrates are supplied in their proper proportions; everything is done and supplied on a regular schedule; nothing is left undone for this child, but he eats like a bird. Possibly he gets enough calcium and phosphorus so his teeth are of fair quality, but his growth lags. The family physician cannot find anything wrong with him, pronounces him organically sound. He has had the advice of the best pediatrician in the city, but still his teeth are crowded, his face is pinched and he is undersized. Primarily he is just a little animal, but is he living a normal life? No, he is living as our so-called advanced civilization dictates, and the physical animal instincts are ruled out.

So he is brought to the orthodontist, and where nature has failed, the orthodontist is expected to develop this face and these jaws, to cope with these adverse conditions, to place normal teeth in normal alignment in an abnormally small, underdeveloped face. What a wise man that orthodontist must be, for against all these odds he very frequently does accomplish what is expected of him, nature and providence assisting. But where is the blame if he should fail?

Then there is another type: a fat, pudgy child of ten years. The flesh of his overly rounded face and of his arms and legs is hard, feels sort of woody and unnatural; his buttocks fill the chair to running over, but there is no muscle there. He is the kind who likes to visit the icebox; he never gets enough to eat. He moves slowly and slumps when sitting. Lazy perhaps; he would rather read a book than play marbles or baseball. Have we here a glandular imbalance? He has pretty good teeth; some decay, less than the average, but the maxillary incisors seem to taper too rapidly to a narrow, thin incisal edge, lateral incisors tending to peg shape, not at all the type of tooth to fit such a facial form. And from the way they are placed in the jaw, one would think some one had thrown a handful of teeth at him and there they grew. One of his parents is the Andy Gump type, the other has a well-developed face with strong, well-formed teeth. These parents wonder why their child should have such funny looking teeth. Can the orthodontist fix them up? Sometimes he can, but where is the blame if he fails?

Then along comes this child's older brother, a fine, big, strapping fellow. No lack of development there; fine face, good lines, big jaws full of life, health, and vigor. "Here are brother's x-ray pictures, doctor," and he is shy five of his permanent teeth and there is room enough in his jaws for forty such teeth as he has. Where is the failure here?

Bring in the next patient, please.

"Doctor, I want you to look at my boy here and see what can be done with him. He is big and strong and is never sick. Our physician says he is in perfect health, but there seems to be something wrong with his bite; he eats in such a funny way. I wish you would look at him and see if something can be done."

We look. A fine face and head, a fine full complement of teeth for thirteen years, regularly aligned in both arches; mouth clean with little sign of gingivitis and no decay. But when we ask this boy to "close, please," we find a distoclusion, a deep overbite with the mandibular incisors pressing 2 or 3 mm. into the maxillary lingual gum tissue.

"Is this boy a mouth-breather?" we ask.

"He should not be. We had his adenoids and tonsils out when he was six years old."

"Was he improved by that operation?"

"I cannot say that we noticed much change after it."

"Does he masticate his food well?"

"He says he can't. It hurts him."

"Did he ever masticate his food very much?"

"Well, when he was small, the doctor told me to feed him meat, so we always ground it up for him so he would not choke. He has always been very fond of hamburger steak and mashed potatoes and gravy."

"Does he like milk?"

"Oh, yes, he drinks two or three glasses at every meal."

So here is a patient who has had good health, good teeth, good food, has had no disturbing physiologic reactions, but never learned to use his teeth.

Well, we can fix him up and give him a fine set of teeth, but he will have to learn all over again how to eat and to use his teeth as teeth were intended to be used. If he does not learn to masticate and make the teeth function properly, our efforts will fail—and where is the blame?

I might go on with case after case, each one a story all its own with all the varied types and conditions with which we are so familiar. I might list all the alibis for failure in our whole repertoire: teeth susceptible to decay and the family dentist's inability to keep up with it; his inability to restore size and mesial, distal and occlusal contours which are so vital in occlusal relations of the teeth; the patient's and the parents' lack of cooperation; the family physician's failure to recognize and correct calcium and vitamin deficiencies, glandular imbalance, allergies of various sorts, diseased tonsils and adenoids, mouth-breathing; various habits, such as sleeping habits, tongue habits in swallowing and speech, finger- and thumb-sucking, nail biting, and so on, down the list, ad infinitum. All these enter into the picture in our everyday work; and our inability to sum them up, to coordinate their each and every interdependent influence is part of the cause of our failures in orthodontics.

With all these interdependent factors entering into the causes and effects of malocclusions, the orthodontists must be supermen to have gained the successes they have gained, and admittedly they have gained many.

Possibly I have given the orthodontist too much credit, and our successes are not so numerous as they should be. But what is a failure in orthodontics? It may be a faulty correction or it may be the inability to maintain a perfect correction. A builder can build no better than the material with which he has to build. His architectural plans may be the best, but they are still subject to the foregoing handicaps and interferences and inhibitions. I do not consider it failure if, in manipulating imperfect material, one does not obtain a perfect result or, having a perfect result, from the standpoint of the teeth and their occlusion, is not able to maintain that result. I do not consider it failure if, in the manipulation of imperfect material, we have brought about an improved esthetic result and a better functional occlusion, even though we have failed to reach our ideal. I am of the opinion that sometimes in what we are prone to call relapses of our efforts, the natural forces have shifted the teeth to attain a better functional occlusion, more in keeping with that individual's particular requirements.

There may, however, be some factors that possibly we overlook in our estimate of a good result. In the past the relation of the teeth in centric occlusion has been too often our guide to perfection, and we have neglected to observe our occlusions in the various ranges of masticatory movements. Too often, in what appears to be a perfect result in centric relation, there are limitations in all other masticatory relationships. We have left such cusp interference as will prohibit any masticatory movement other than a chopping up and down in centric occlusion.

To the best of my knowledge, Dr. George H. Maxwell, of Chicago, has given us the first definite detailed description of an ideal occlusion that will permit of all the ranges of masticatory movement. He has propounded a theory of ideal occlusion which gives us a more definite goal for which to strive than we have had heretofore. Correct interdigitation of the teeth and proper correlation of cusp heights and angles will produce a condition of functional equilibrium in the various ranges of occluding relationships which should do much to maintain the integrity of the dental arch.

Dr. Maxwell stresses equitable distribution of force as against equal distribution of force, equitable for the individual teeth taken collectively. His studies deal almost entirely with the occluding contact relationships of the teeth at centric and through the functional ranges from lateral to centric or protensive to centric.

He states that mandibular motion is three-dimensional angular and therefore must be definitely hooked up with spherical principles. He has divided the cusps of the teeth into two groups—major and minor—so that in an arrangement of teeth to the ideal the major cusps so closely approximate the surface of a sphere that it should be a helpful guide to us in determining when we have attained a good result. To maintain a perfect occlusal relation, each integral part of the occlusal mechanism must be given an opportunity to perform its proper function. If we can attain all the normal functional relationships of all the elements of a normal occlusion, as Dr. Maxwell has described them, we have the best assurance obtainable that these relationships will be maintained,

and through the functional forces of occlusion there should follow normal facial and dental development, subject, of course, to our ability to impress upon the patient that he must use all the functional ranges we have made possible, and not drift back to his old habits of using only the restricted movements of his former condition.

I have also seen numerous instances of appliances being placed on teeth, presumably to make a correction, where in my opinion, if the case had been carefully observed with accurate records for a period of six months or possibly a year or more, natural forces would have operated to make treatment unnecessary. The press for new business may possibly have been a deciding factor, but we must not lose sight of the fact that we are public servants and that the welfare of the patient should be our first consideration.

The one thing more than all others that has tended to cast discredit on the practice of orthodontics has been the tendency of the orthodontist to leave the inference with the patient and parent that the case is going to turn out perfectly when he knows well enough before he starts that there are handicaps that make it well-nigh impossible to attain a perfect result. So often we hear people say, "Son-and-so had his teeth straightened for three or four or five years, and they went right back again." Straightforward honesty is not always employed. Had the parents been impressed with the fact that there are limitations in many cases beyond which no orthodontist can go, such remarks would be less frequent.

The next in order of causes for discredit is the orthodontist's inability sufficiently to impress both patient and parent with the importance of their cooperation in attaining a good result. When I speak of cooperation I have in mind not only adherence to the instructions of the orthodontist as to the care of the teeth, breathing and muscle exercises, etc., but cooperation in the matter of keeping appointments so that the orthodontist can carry out the needed adjustment of appliances until such time as the treatments are completed. In my experience I have been unable to complete satisfactorily many cases because in the middle of the treatment the patient has been sent away to school, or to Europe, and, as much as I regret to have to say it, two operators at distant points dividing the responsibility in the treatment of an orthodontic case seldom reach a happy result.

Roughly speaking, the cooperation of all concerned in a case is 50 per cent of the treatment. I would not care to state in what percentage of cases cooperation is lacking, but the orthodontist must bear the blame if he is unable to obtain it.

I cannot refrain at this point from laying some of the blame for our failures at the feet of the family dentist. It is a well-known fact that normal teeth and arches are in a state of constant flux and change from the time of eruption of the first deciduous tooth throughout the entire lifetime. During the long growth period until all the permanent teeth are erupted into their occlusal relationships, there is a constant migration of the teeth, particularly in their relation to the skull and upper face. The growth of the maxilla and the mandible carries the teeth forward and downward from the cranial base.

The normal forward inclination of the teeth themselves, through the normal forces of occlusion, helps to drive them all forward. These are the normal physiological movements of the teeth.

When growth and development are completed, further movement takes place as a result of functional wearing away of tooth substance, with a constant change of dimension. Then, when decay intervenes, as it does in 97 per cent of our population, and both mesiodistal and occlusal dimensions are lost, a further change and drift take place.

This is where the dentist's responsibility begins. Does he always know what the normal dimension of a tooth should be? How often he merely fills a tooth to proximal and occlusal contact, leaving the contour and lost mesiodistal diameter of the tooth unrestored. Or possibly he has that lost dimension in mind, and after preparing the tooth for a restoration, places a temporary filling of gutta percha in the cavity until he can make an inlay, or until the next appointment a week or so later. In the meantime that temporary filling is being pounded and wedged by the forces of occlusion between the cavity wall and the adjacent tooth. Further migration takes place, and when the patient returns for inlay restoration, more contour must be added to fill the increased space. If too much space has been made, does he fill it? If too little space has been attained, does he place his filling to contact only? Usually he does. Does he consider the dimension that tooth should have? Many do, but many do not, and the teeth continue to drift, either to make more work for the orthodontist or to discredit his efforts.

In so many of our cases, proximal decay occurs in premolars, even before their contacts have been closed by the normal forward drift of the molars. How often I have seen such patients return from their family dentist with these normal spaces closed by beautifully overcontoured inlays that again change the dimension of the tooth and produce further drift.

Now, while I am scoring the family dentist, I may as well add one more comment. The amazing variety of size, contour and position of the fifth or distal cusp placed in mandibular first permanent molar restorations makes me wonder if dental anatomy is still being taught. This is a very important cusp, both in its position and in its proximal contact relation with the second molar, and particularly in its occlusal relation. If improperly placed, it will make normal occlusion impossible.

The placing of occlusal sulci in molars and bicuspids, the position and the contour of marginal ridges in dental restorations are of prime importance in the maintenance or marring of occlusal relations, and, if improperly formed and placed, will do still more to unbalance these relations. How beautifully nature has planned these marginal ridges to receive a cusp of an opposing tooth, and how often the scourge of decay occurs to mar them. How beautifully nature has planned the contacts of adjacent teeth to form spillways for food during the act of mastication; and again how often the scourge of decay makes it necessary for the dentist to use all the skill and artistry of sculpture in his power to recapture normal size and position and contour in restoring lost tooth substance. Is he meeting his responsibility? I have hinted that he sometimes

does not. Are we to blame dental education for not stressing dental anatomy more, or are we at fault for not impressing upon dental teachers and dental practitioners the vital importance of tooth contours and dimensions in the functioning of the dental structures? For, after all is said and done, the mechanics of these cusps, marginal ridges, proximal contacts, acted upon through the forces of occlusion, are of prime importance in the maintenance of normal occlusal relations and the consequent development of the jaws and face.

In summing up, then, we find that orthodontics is not merely the science of moving teeth here and there in the hope of emulating Angle's *secretum apertum,* but requires of the orthodontist a comprehensive knowledge of the science of growth and development and a working concept of the biochemical processes of metabolism, so that he may recognize not only the malocclusions but also the adverse influences that enter into the production of malocclusion. Some of us possibly at times fail to do the best that can be done for our patients through lack of knowledge, experience, judgment, and a proper sense of the mechanics of the appliances we have to work with. The mechanics of our appliances is not an exact engineering problem because the foundation for our building cannot be definitely measured. We are manipulating living tissues that react, not according to the laws of physics alone, but to the laws of physiology, biology, chemistry and inheritance as well.

I have not tried to condone failures by this recital of numerous reasons why we fail, and many of us do fail to reach our ideals; but, after many years in the practice of orthodontics, I have concluded in my own mind that it is just as much a folly to try to attain the ideal in some cases as it would be to have no ideal.

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WHY DO WE HAVE ORTHODONTIC FAILURES?

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THE term "failure" has a wide variety of meaning. As defined in the Standard Dictionary, the more important applications are:

I. To forsake, neglect or deceive; that which is deficient, inadequate or anything done imperfectly or attempted unsuccessfully.
II. To fail by losing flesh, strength, or waste away.
III. To cease business because unable to meet financial obligations, become insolvent, make an assignment, become bankrupt.

The foregoing surely offer a range so broad that one may choose to address you from a number of viewpoints, such as that of an art, a profession, or a business. Since our colleagues in general dentistry credit the orthodontist with being a good business man, I might have selected the third definition as my topic, because I believe that the misunderstanding by the general practitioner of the orthodontic problem is due in large part to the failure of the orthodontist really to acquaint him with the science underlying the specialty as a basis for the art of its practice. Were he fully informed, he would not think orthodontics simple, its practice easy, and its earnings large. We could soon point out to him that, unhappily, some orthodontists have failed to meet their obligations, have had to discontinue special practice, and seek employment in other fields.

I might also have chosen the second application and elaborated on those temptations that lure orthodontists so that they "fail by losing flesh and waste away." I fear, however, that were I to attempt this I should, as a personal exhibit, be laughed from the platform.

I shall, therefore, direct you to the first definition, "that which is deficient, inadequate, or anything done imperfectly or attempted unsuccessfully."

Orthodontics, like any division of the health services, cannot always be wholly successful. There are too many variables to permit this. But it can, with increased knowledge and its dissemination especially among its own practitioners, reduce the number and extent of its failures. This the specialty has always striven to do and, may I say, not without success. When one contemplates that it is only forty years since so-called modern orthodontics had its inception, and this in a most modest beginning, there is no just cause for self-criticism. In fact, I know of no branch of dentistry in which so much collateral fundamental science has been garnered and assimilated. This has resulted largely from the interest of scientists outside the field of our practice while most valuable and practical contributions have also been, and are now being, made from within our own ranks.

The foremost cause for failures in practice, I feel, comes as a result of the inadequate facilities for orthodontic education which have prevailed until quite recently.

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The importance of the specialty had not sufficiently impressed itself upon institutions of learning until within the past decade. Now, however, this is being corrected quickly. The universities have recognized its value as a health service, and thirteen of the thirty-nine universities having dental schools have announced courses in graduate and postgraduate orthodontics. While curriculums are as yet far apart in some instances, this will soon be corrected, and contemporary practice will in a very few years be based on relatively uniform fundamentals in science. This accomplished, it will quickly result in relative uniformity in the art of practice. Then, indeed, will one of the greatest causes of our failures have been overcome.

In the immediate past, the variance in treatment in different localities was so extreme that it was sometimes difficult to know to whom to refer patients either for emergency or for continuation treatment. The outspoken criticism of some specialists when being consulted by referred patients impressed me as being nothing short of disgraceful professional conduct. The insistence of replacing all appliances in the mouth with those of their own making was, I believe, quite uncalled for.

It usually resulted in engendering hard feeling between specialists and also placed the patient in a serious quandary. Such unprofessional conduct resulted in lowering the confidence of the patient in orthodontics, was offensive to the dentist who referred the patient, and was beyond the comprehension of the physician and the surgeon. It must also have shocked the intelligent layman, who is, after all, the parent of our patients. Such confidence-destroying conduct could not but lessen cooperation by patient and dentist and must have contributed to the number of our failures. Respectful cooperation between specialists and kindly approval of the efforts of others command respect for any specialty.

Support of the dentist and physician is also most important in reducing failures. We should inform them of the problems of our special work and stimulate their interest, understanding, and assistance.

The orthodontic problem may conveniently be considered under four divisions:

1. Preventive malocclusion or prevention in orthodontics
2. Corrective orthodontics
3. Posttreatment observation
4. Tooth positioning for adults.

We cannot feel that this entire problem belongs strictly to the orthodontist, although some general practitioners may prefer that the specialist take full responsibility and refer all patients.

1. We feel that *preventive malocclusion* and the underlying principles should be thoroughly taught the undergraduate student. He can be told that it is his duty either to give attention to this in his practice or to refer it, as he may wish. He cannot escape, however, the responsibility of recognizing early the factors which predispose to malocclusion and of overcoming them himself or of advising the parent to consult an orthodontist. By so doing we believe that from 35 to 50 per cent of aggravated complicated cases can be prevented.

2. *Corrective orthodontics* is strictly the duty and the field of the specialist in orthodontics and preferably the exclusive specialist—more will be said of him later.

3. *Posttreatment observation* should be a divided duty between the orthodontist and the dentist. For from one to two years following completion of active treatment, the specialist should continue responsibility; then the dentist usually should assume it, because patients, as a rule, do not like to have to go regularly to two offices. By good understanding between them, the dentist should be fully capable of observing if correct occlusion is being maintained and if not, to refer the patient to the specialist who gave the active treatment, when possible.

4. *Tooth positioning for adults* as for facilitating restorative procedures can be done by the dentist if he wishes. It involves tooth movement only; he knows what positions he desires the remaining natural teeth to occupy, and he should be able to bring about the desired movement. If, however, he prefers that the orthodontist attend to this, a thorough understanding of the new positions should be plotted in advance.

If the foregoing analysis of the general problem were accepted and understood by all concerned, I believe many of our differences of opinion and failures would soon be materially reduced. So much by way of general considerations. Let me now give attention to failures of and by the exclusive specialist.

An exclusive specialist in orthodontics is a dental graduate who has had the courage to announce himself an orthodontist. He is a specialist by proclamation in all but three states of our country and Canada. Whether or not he is an orthodontist also by education is a matter solely of his own conscience. The difficulty of obtaining an adequate course of instruction is now a thing of the past. To those specialists who have been in practice for some years, may I recommend short intensive courses for orthodontists. They are being offered under extension teaching by some universities and will do much to bring one's knowledge of the newer scientific fundamentals and treatment procedures up to date. They interfere very little with practice. No single factor will tend to reduce failures more than this. The application of fundamental science to our work is, of course, the greatest of factors in reducing the percentage of our failures.

The study of the physiology of head development and growth being made by one of our own members is noteworthy. B. Holly Broadbent, working as an associate of T. Wingate Todd under the Bolton Fund at Western Reserve University, is making an invaluable study, which, when assimilated and applied, will greatly reduce the number of failures. I believe that any orthodontist who does not study and apply this work is guilty of professional negligence.

Fig. 1 has been prepared for the purpose of illustrating the biologic concept of growth oriented to the development of occlusion from conception to maturity. The periods of accelerated horizontal growth were determined by T. Wingate Todd. The period of most rapid horizontal growth is from the twenty-first day after birth to the seventh month, at which time the first of the decid-

uous teeth usually erupts; the second most rapid period is from the fourth to the seventh year, and the third is from the sixteenth to the nineteenth year. The scheme was suggested by Harry Wright, who adopted it from an illustration used in physiology by Professor Ludholz. A somewhat similar chart was published four years ago. This illustration has recently been prepared in its present form and is used to describe what, to me, is the orthodontic ideal in diagnosis and principle of treatment. I believe the more nearly our knowledge and skill permit us to attain this, the better will be the quality of our service.

On the left in Fig. 1 the male and female pronuclei are represented by two black dots. These fuse to form the fecundated ovum. Heredity is sealed when this has taken place. All that is given us by ancestors is herein contained. Development is the expression of the genes contributed by both parents. This affects the face, jaws, and teeth as it does all parts of the body. It seems reasonable to assume that, if there could be no retarding environmental influences from fertilization to maturity, the face, jaws, and occlusion would attain full

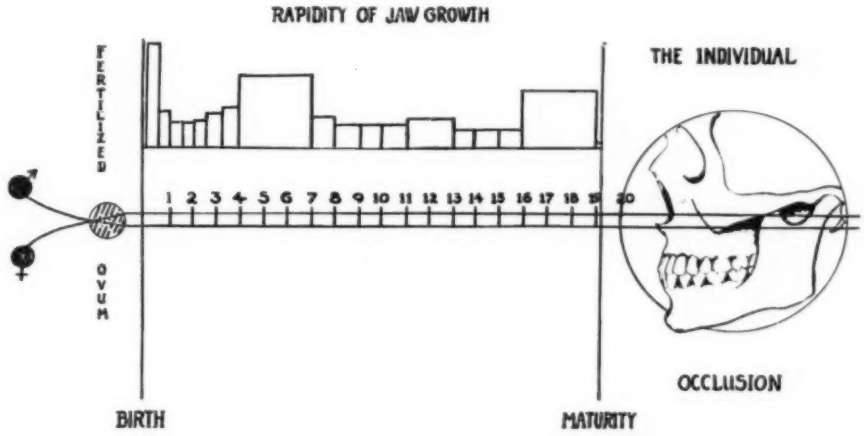

Fig. 1.—Description in text. The drawing was made by Armand Oppenheimer, a colleague in orthodontics.

possibilities and be predetermined by the heredity of each individual. This does not imply, however, that it would be a normal face or jaw or a normal occlusion. It would, in fact, frequently result in malocclusion with malformed jaws, face, and body. This cause is responsible for the most obscure and extreme cases which are so difficult to treat successfully. Environmental influences, however, may be said to exert invariably an influence at some time during the developmental period, and these should be promptly recognized and overcome.

That there are periods of comparatively rapid and slow jaw growth has been convincingly shown by Todd. There are actively growing in the jaws at birth, twenty-four tooth follicles, twenty for the deciduous teeth and four for the permanent first molars. The first of the deciduous teeth to erupt is the mandibular central incisor at about the seventh month after birth.

There follows a period of slower horizontal growth, with vertical growth going on as the teeth successively erupt and grow vertically to the line of occlusion. At this early age, the services of the orthodontist are very seldom

sought. There are two considerations, however, that should concern him. First, that the gymnastics of natural suckling be instituted, should the infant be partly or wholly bottle fed. The mother should be urged to use an artificial feeding nipple that will compel the movements and effort of the involved musculature that would be exercised in natural feeding. And, second, the mother and the nurse should be warned against the practice of nudging the infant on the point of the chin to waken it. We fear that this practice, if continued, may influence detrimentally the growth and position of the mandible by tending to produce distal position of the mandible.

The second period of most rapid horizontal growth is from the fourth to the seventh year. This is a most important age range from the standpoint of the orthodontist, for at this time decisions of great importance must very often be made.

There are in the jaws more teeth and follicles than at any other time in life. There are twenty deciduous teeth completely formed and in occlusion, and in addition there are the actively growing follicles of twenty-four permanent teeth, making a total of forty-four teeth and follicles. Little wonder, then, that developmental spacing is frequently disturbed. The knowledge and skill of both the orthodontist and the dentist are given their severest test during this transitional period from deciduous to permanent dentition. The dentist is called upon to do proper restorative work for children, including properly contoured fillings and placement of space retainers when teeth are prematurely lost, and also to refer patients when jaw development and growth do not take place properly. The orthodontist is called upon for best judgment as to when and how the necessary treatment is to be given.

The third period of most rapid horizontal jaw growth is from the sixteenth to the nineteenth year. At this time there are the four follicles of the third molars, with full size crowns, obeying the developmental urge to erupt. Additional horizontal jaw area must be grown if they are to find normal positions. This is frequently a period of keen anxiety for the orthodontist and of disappointment for the patient. The oral surgeon is often needed to prevent failure of an otherwise successful treatment.

Knowing the average normal periods or ranges of jaw growth and tooth eruption, the orthodontist should be in a position to compare the mouth condition with that of the body in general and be able to decide whether all is progressing properly. If not, procedures should be instituted to stimulate mouth and tooth growth into harmony with that of the body as a whole. This accomplished, he should give nature a chance, carefully observing that it is taking place. Should it continue, no further active treatment will be indicated. If, however, there is another lag, active treatment is called for. In this way the patient is under orthodontic care during the developmental age but is required to undergo treatment only during the periods when it is necessary. To explain in popular language, there is a predetermined highway from fertilization to the completed dentition. Only when growth and development detour from this

highway is orthodontic assistance called for, and as soon as the malgrowth is guided back on to the highway, step aside and let nature take its course, but be systematically on the lookout for another detour. Should it occur, then repeat until maturity is attained. Thus should the normal be brought about for each individual, by the simplest possible treatment and the least wearing of appliances.

Probably the most common clinical cause for failures is the too great eagerness to begin appliance treatment of the new case. Neglect to obtain complete records and to study them thoroughly before making diagnosis, classification, and outline of treatment is improper practice and very frequently leads to prolonged treatment and to failure. I have used the following procedure with satisfaction:—

REQUIREMENTS FOR ORTHODONTIC DIAGNOSIS AND CLASSIFICATION

1. Personal examination of patient.
2. History—as complete as possible.
3. Thorough check-up of nasal region and air passages (by rhinologist).
4. Complete set of radiograms, intra- and extraoral.
5. Casts of teeth from accurate impressions.
6. Photostatic facial reproductions.
7. Graphs or plane reproductions—very valuable—Simon method, orthodontoscope.

Each step should be elaborated, but lack of time will forbid. Those who do not use graphs may find the method of Strang helpful. Both the mouth and casts are studied and recorded.

CASE ANALYSIS (AFTER STRANG)

(Angle classification used)

1. Inclined plane relationship.
2. Axial inclination.
3. Radiograms { supernumerary teeth / missing teeth / malformations.
4. Molar rotation.
5. Median line relationship.
6. Photograms—preferably oriented to fixed plane.

The sequential steps in treatment should be concisely written out and followed.

ORTHODONTIC TREATMENT

1. Physiologic—thorough use in mastication, deglutition, speech and breathing.
2. Psychologic—habit breaking, clear enunciation, thorough functioning.
3. Artificial exercisers—rubber bite strap.
4. Myofunctional therapy (after Alfred P. Rogers).

5. Medical aid as by pediatrist and rhinologist—patients can frequently be referred to advantage.

6. Surgical—removal of supernumerary teeth, exposure of impactions, cleft palate, cleft lip, etc.

7. Appliance therapy.

The essential question in appliance therapy is when and not how. There is just one best time to begin appliance treatment. There are a number of methods as to how it may be done, each of which if properly applied will produce satisfactory results.

In making the important decisions as to when to place appliances, I invariably ask myself this pointed question: "Were this a child in my own family, would I burden the little mouth with appliances now?" Thus, all considera-

Fig. 2.

Fig. 3.

Fig. 2.—Primitive Eskimo man, Hooper Bay, Alaska. Molar biting strength 345 pounds. Note prominence of flexed temporal and masseter muscles and strong development at angle and ramus of the mandible.

Fig. 3.—Eskimo girl 8 years old, biting strength 194 pounds which is 14 pounds greater than the strongest bite of the 108 athletes of the football squad of University of Minnesota, reported by Brekhus-Armstrong. The same model of gnathodynamometer was used. It was tested at the Bureau of Standards, Washington, after returning from Alaska and its correctness certified.

tions are eliminated except the essential one of deciding upon the best procedure. Even when the answer is against appliances now, if there is tendency to lack of proper development and growth, I recommend that the seven requirements for an orthodontic diagnosis and classification be followed as outlined. This record, including casts, radiograms and photograms, will serve as a means of comparing the progressive growth as the patient returns at stated intervals for observation. Without these records, the visits for observation are largely futile because accurate comparison is impossible. If growth is abnormal, then treatment is prescribed and carefully followed as outlined under orthodontic treatment. And may I reiterate that appliances are used as a last resort and

kept in the mouth for as short a period as possible to obtain the desired result. The importance of posttreatment cooperation is stressed, and the patient is required to return at intervals for observation until it is considered best to shift this to the family dentist, who is requested to send the patient back whenever he is in doubt.

The importance of thorough use of the jaws and teeth is strikingly shown in the Eskimo. On my recent trip I took a gnathodynamometer (Brekhus-

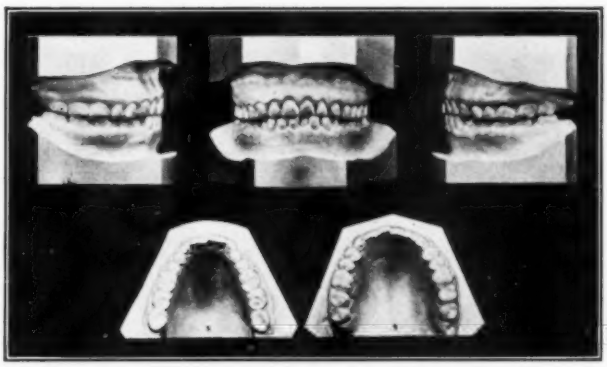

Fig. 4.—Casts of Eskimo woman of King Island, Bering Sea. Thirty-two teeth in excellent occlusion, supported by strong alveolar process, considerably worn and caries-free. She is the aunt and about 9 years older than her nephew, whose casts are shown in Fig. 5.

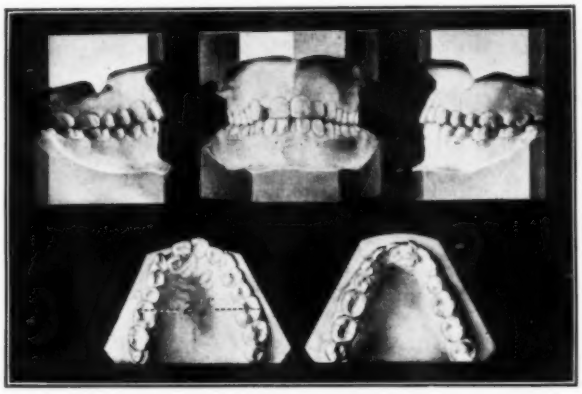

Fig. 5.—Casts of an Eskimo boy born on King Island, Bering Sea. Casts of his aunt's teeth shown in Fig. 4. He was taken to Nome when about 9 years old and was reared there on the nonresistant foods of white man during the growing period. Note the crowding and overlapping of teeth in the anterior segment of the jaw. This change occurred in one generation.

TABLE I

AVERAGE BITING STRENGTH

SEX	NUMBER	AGE* (YR.)	WEIGHT (LB.)	HEIGHT (IN.)	BITE (LB.)	STRONGEST BITE (LB.)
Primitive Alaskan Eskimo (Tundra Villages of the Yukon-Kuskokwim Delta and Adjacent Islands)						
Males	55	35	127	63.84	297	345
Females	22	27	128	60.15	260	310
Football Squad†						
Males	108	21	176	72.00	126	180

*Age range 16 to 55 years—estimated.

†University of Minnesota, 1936 (Brekhus-Armstrong).

Armstrong) with me. The following findings, I believe, are important to the orthodontist as they should serve to convince him of the stimulation of jaw growth resulting from the vigorous chewing of resistant foods. Especially is this important during the growth period. It should also assure him of the benefits of myofunctional therapy as recommended by Alfred P. Rogers.

I have endeavored to stress some of the more important considerations that I feel should be followed in practice, day in and day out. If these are studiously applied, I believe we shall reduce considerably the percentage of our failures, bring about a better appreciation of our specialty by the dentist, physician, and all health workers and shall, indeed, much better serve and please our patients.

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THE PLACE OF CHROME ALLOY IN MODERN ORTHODONTICS

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ONE hesitates to dwell at too great length on the mechanical phases of orthodontics; too frequently we ignore the fact that we are mechanically treating biological structures which may respond physiologically or pathologically. This response may be dependent on the materials used.

Chrome alloy has passed well beyond the experimental stage and is established as a material that does not require an expert technician either to weld or to solder it. Chrome is being used by men who only weld it, and it is being used just as successfully by those who only solder; many men utilize a combination of both methods. All types of appliances and attachments can be used.

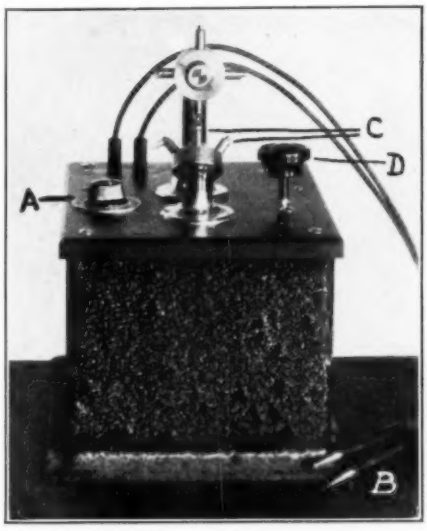

Fig. 1.—Rocky Mountain spot welder: *A*, Rheostat; *B*, annealer points; *C*, welding points on turret head; *D*, switch.

Undoubtedly many orthodontists have tried out different stainless steel products, some of which may not even have been suited to orthodontic purposes. Others may have tried a legitimate chrome alloy, only to meet with failure due to faulty technique.

I, too, have been through the trial and error method in the use of chrome. In 1932, while Brusse and Carman were experimenting with U. S. stainless steel, I was working with Krupp-Renfert chrome. Since that time I have used chrome alloy exclusively, gradually eliminating precious metal from my practice.

Read at the Thirty-Sixth Annual Meeting of the American Association of Orthodontists, Los Angeles, Calif., July, 1938.

My technique utilizes both welding and soldering and is illustrated herein. All attachments to bands—tubes, brackets, hooks, etc.—are welded; my bands are specially lapped and welded along the lapped point. Springs and hooks on arch wires, however, are attached by soldering. I use the Rocky Mountain Metal Products Company welder (Fig. 1), their materials, attachments, and flux, and Williams 14 karat, 490, fine, 28 gauge wire solder. The special Rocky Mountain tip for orthodontic torches is also used (Fig. 2).

Using this technique and equipment, the following breakage occurred: during 1937 the number of patients under treatment averaged 230, and these patients all together totaled only 125 broken appliances, bands, springs, inter-

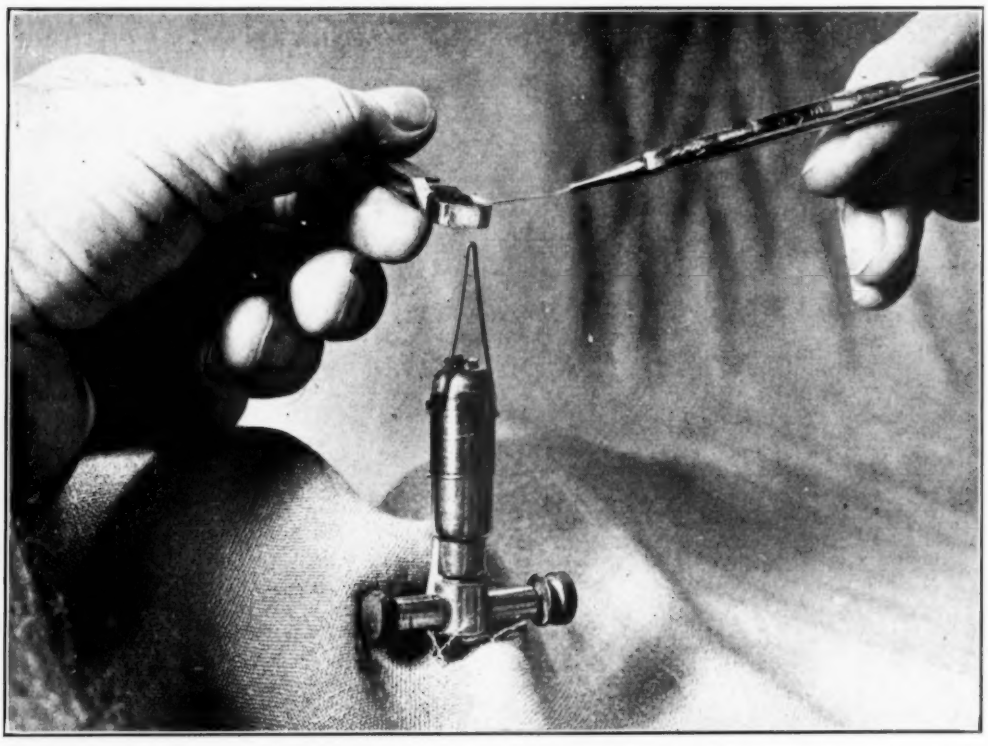

Fig. 2.—The proper relation of band to point of flame outlined by the wire framework for soldering. Note formation of crust caused by the heated flux.

Note the tip attached on the torch, making a flame that does not blow out. Natural gas and air are used.

maxillary hooks, etc., an average of 0.543 per cent per patient. These 230 patients filled 3,573 appointments, averaging one broken appliance or band out of every 24.66 visits. This breakage record, carefully compiled by a certified public accountant, clearly demonstrates the superiority of chrome alloy over other materials from the standpoint of appliance strength. In an effort to popularize the use of chrome alloy for all technics and types of appliances, I have included both soldering and welding technics in this paper. No emphasis is placed on any type and method of treatment; only basic technic is demonstrated.

POSTERIOR BANDS

A. *Soldered.*—Cut the Rocky Mountain band material, preferably 0.180 × 0.006, 1 mm. shorter than the measurement of the tooth at its greatest diameter; then lap 1 mm. (thus making the completed band 2 mm. smaller than the tooth). Flux the outer surface at the lap with Rocky Mountain flux and hold in the flame until a white crust is formed (Fig. 3*A*). Then flow on Williams 14 karat, wire solder, assuming the relative positions of the band to the flame as shown in Fig. 2. If there are any carbonized areas, grind off, reflux, and flow on more solder (Fig. 3 *B*). Using Rocky Mountain band stretchers, and contouring pliers, form the band properly.

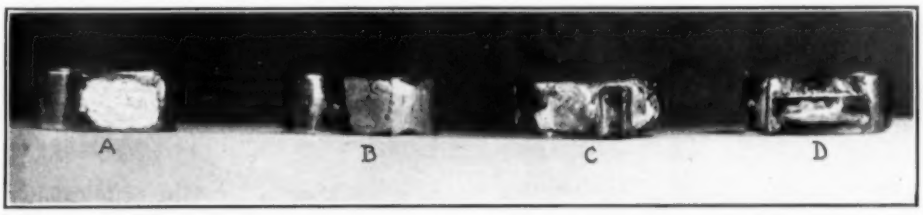

Fig. 3.—Soldered bands and attachments: *A*, the white crust formed by fluxing at the lapped joint for soldering; *B*, the completed soldered joint; *C*, oval tube; *D*, buccal tube.

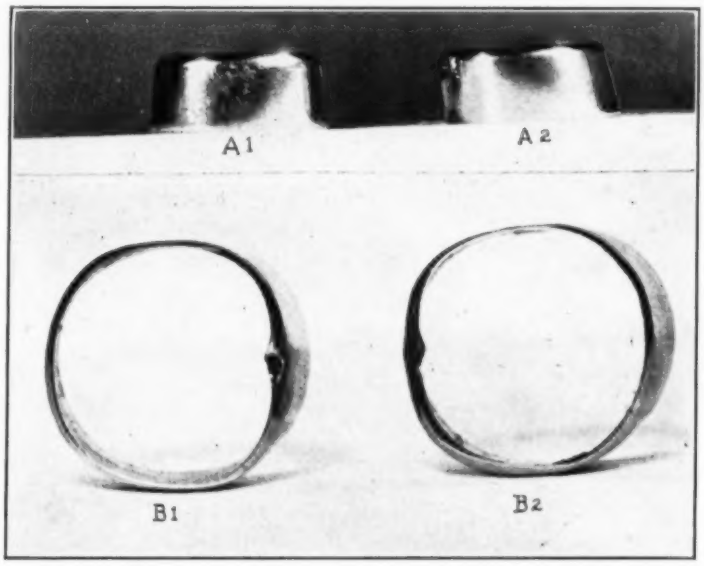

Fig. 4.—The Rocky Mountain Tru-form Band. *A*, Mesial distal views. (1) Maxillary, note lingual inclination and crimped in occlusal. (2) Mandibular, note buccal inclination and also crimped in occlusal. *B*, Occlusal views. (1) Maxillary, note groove on buccal for proper fitting. (2) Mandibular, note groove is on lingual for proper fitting.

B. *Welded.*—Cut the band materials the same length as before described, lap and weld six or eight times at the lap (Fig. 6 *F*). It is not necessary for the band material to show red in the process of welding. Then stretch and contour to proper size with the Rocky Mountain band stretchers and pliers.

Both soldering and welding can be eliminated if the Tru-form bands made by Rocky Mountain are used (Fig. 4). These are made to tooth form in various sizes and are easily fitted.

C. *Attachments to Posterior Bands.*—(Oval or buccal tubes.)

(1) Soldered. Flux the tube with Rocky Mountain flux and flow solder on it; then flux and flow solder on band. Grind off any carbonized areas, reflux, and assuming position shown in Fig. 5, unite (Fig. 3 *C-D*).

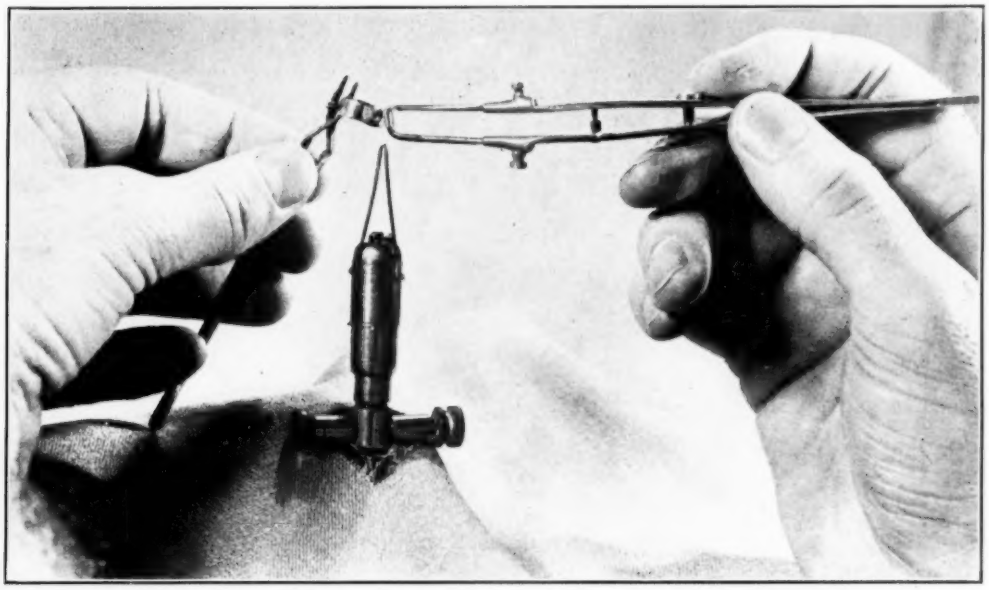

Fig. 5.—The proper relation of tube and band to flame point in soldering on the oval or buccal tubes.

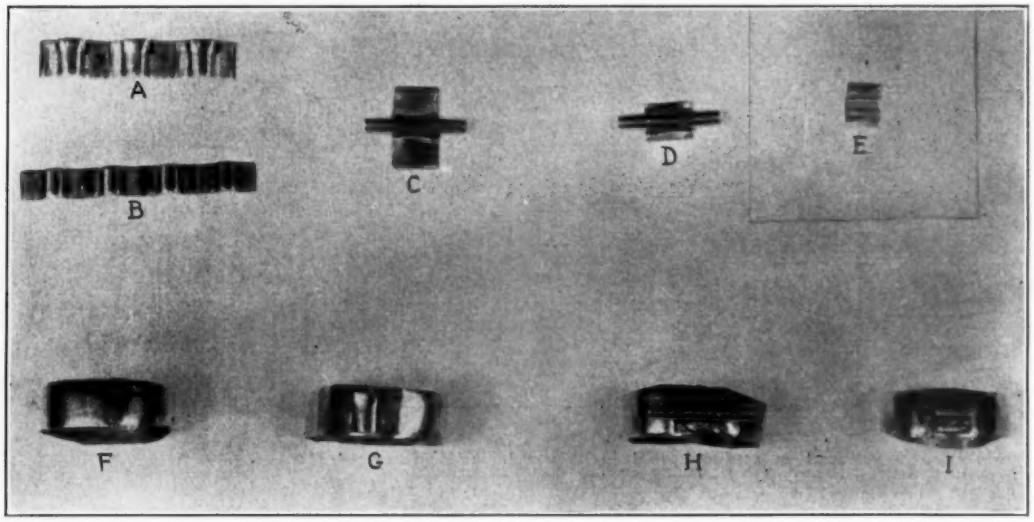

Fig. 6.—Welded bands and attachments. *A*, The Rocky Mountain 0.036 flanged oval tube. *B*, The Rocky Mountain 0.030 flanged oval tube. *C*, The Rocky Mountain 0.036 flanged buccal tube. *D*, 0.036 buccal tube with flanges cut more narrow. *E*, Special Rocky Mountain 0.030 buccal tube for deciduous molars. *F*, Welded molar band. *G*, Flange oval tube welded on molar band. *H*, Flange buccal tube welded on band. *I*, Flange narrow buccal tube welded on band.

(2) Welded. Place the Rocky Mountain flanged tube (Fig. 6 *A-E*), the flanges of which have been annealed in its proper position, and weld lightly in one spot, preferably on the gingival for the buccal tube and the mesial for

the oval tube; check to see if it is in the proper position; if correct, complete welding, spotting five or six times on each flange (Fig. 6 *G, H, I*). If in incorrect positions, they can be twisted loose from the band and realigned. Note that the oval tube flanges straddle the groove on the surface of the lingual; also, that a small amount of the band is occlusal and gingeval to the flanged buccal and lingual tubes to permit better adaptation.

The flanged buccal tubes are cut narrower (Fig. 6 *C-D*) for better adaptation at the occlusal and gingival and to prevent interference with the occlusion.

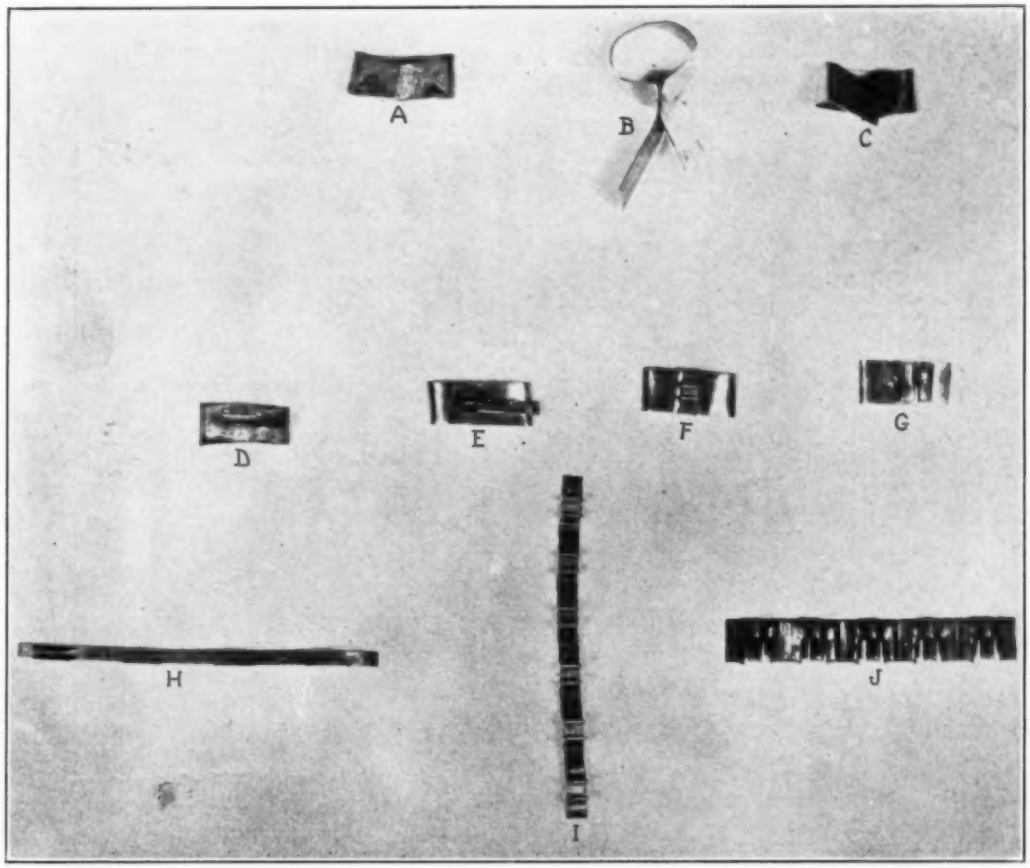

Fig. 7.—Soldered and welded anterior bands and attachments. *A*, The lapped soldered band. *B*, The pinched band, preparatory to welding. *C*, The lapped welded band. *D*, McCoy open tube soldered on band. *E*, McCoy open tube welded on band. *F*, Rocky Mountain 0.022 channel bracket welded on band. *G*, Rocky Mountain K-hook welded on band. *H*, Rocky Mountain McCoy open tubes. *I*, Rocky Mountain 0.022 channels. *J*, Rocky Mountain K-hooks.

Oval tubes are made to fit 0.036, 0.032, and 0.030 wire; buccal tubes to fit 0.040, 0.036, 0.030, 0.022, and 0.028 × 0.022.

ANTERIOR BANDS

A. *Soldered.*—A preliminary pinch is made to determine the size, a 1 mm. lap is made and then fluxed and soldered. The Rocky Mountain anterior band stretcher and contouring pliers are used to obtain proper adaptation (Fig. 7 *A*).

B. *Welded.*—The pinch and lap are made as above, and the lap is spot welded five or six times, care being exercised not to burn the joint (Fig. 7 *B, C*).

C. *Attachments to Anterior Bands.*—McCoy open tubes, Ketchum hooks, and snap channels are easily attached. In soldering, flux well and flow solder on both the band and the attachment, and then unite (Fig. 7 *D*). In welding, spot once, check for proper position, twisting off and realigning if necessary; then complete welding (Fig. 7 *E, F, G*). Care must be exercised not to overheat either in soldering or in welding.

LINGUAL ARCH CONSTRUCTION

The arch can be made of 0.036, 0.032, and 0.030. Using the Ellis post-bending pliers made by the Williams Company, form the Ellis posts (Fig. 8). A great deal of breakage is eliminated by the process conceived by Dr. W. B.

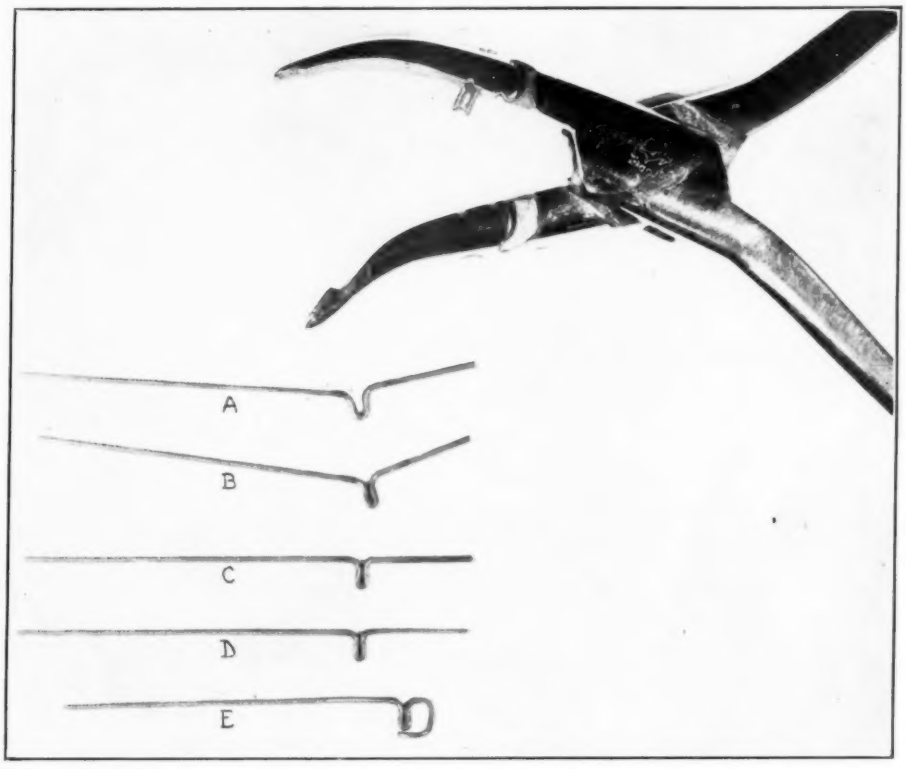

Fig. 8.—The Williams Co. Ellis post-forming pliers and the bends made in forming the Ellis post. *A*, First bend. *B*, Second bend. *C*, Completed post. *D*, Portion of wire distal to post annealed and ground down for lock. *E*, The completed Ellis post and lock.

Stevenson; i.e., annealing the portion of the arch wire extending posterior to the post formed, grinding it down to 0.025, and forming the lock spring as a continuous portion of the wire (Fig. 8 *D*).

The arch can be made by the direct or the indirect method, annealing being possible for adaptation in the latter. Care must be taken not to anneal the arch to a red heat, permitting only a slight discoloration of the wire to occur and annealing only a small portion at a time.

The soldered lingual can be constructed if desired. Plenty of flux will help avoid carbonization. Wet asbestos fibers packed just anterior to the soldered joint will help prevent loss of resiliency.

A. *Attachments to the Lingual Arch.*—

1. *Soldered.*—Plain, recurved, or loop spring. Flux and flow solder on both the arch and the 0.018 spring wire and then unite, care being taken not

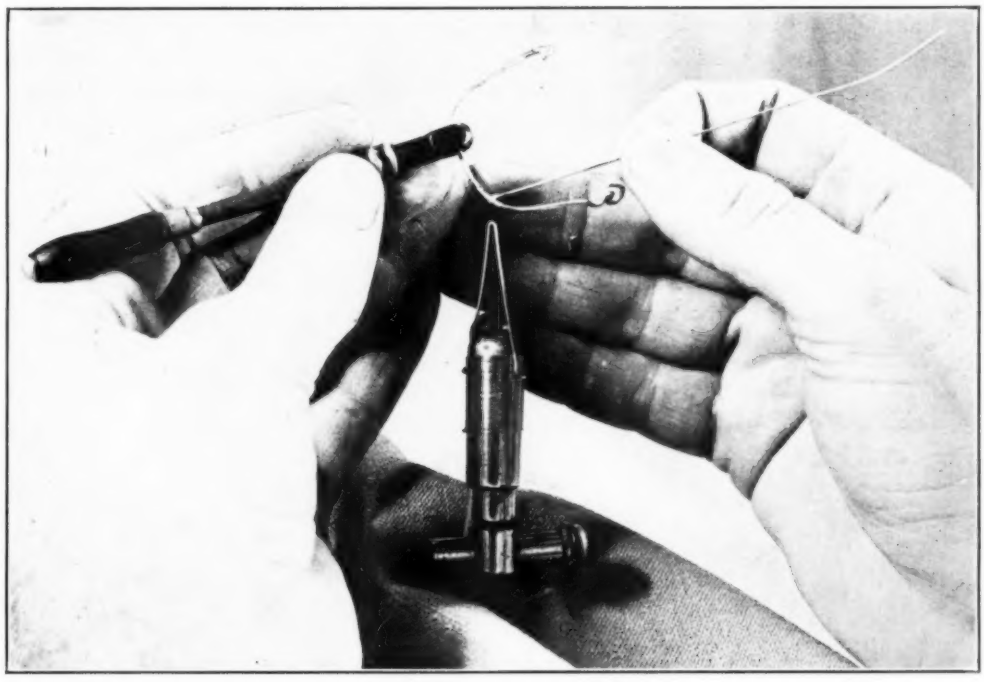

Fig. 9.—The proper relation of arch wire and spring wire to the point of flame for soldering.

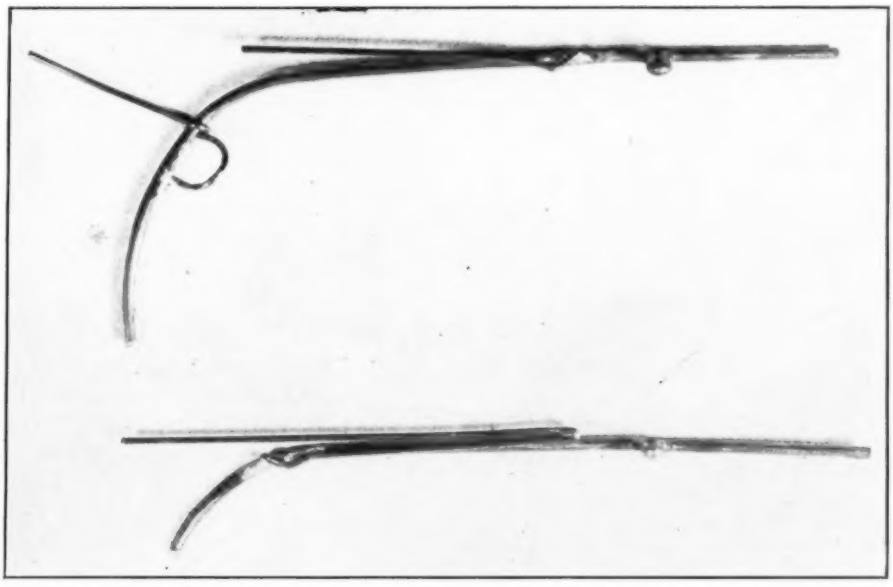

Fig. 10.—Springs attached to the arch wire by soldering. Note the slight amount of discoloration at the soldered joint.

to lose the elasticity of the wire (Fig. 10). The proper size flame of gas and air and the proper position for soldering are shown in Fig. 9. A brief slight reddening will not cause a loss of resilient strength in the lingual, but will

cause some loss of resiliency in the smaller wires. If such loss does occur, it can be restored by twisting the 0.018 spring wire on itself once or twice.

2. *Welded.*—Either of two types of welded spring may be used—the wrapped type (Fig. 11 *A*) or the indirect welded type which is made by welding the spring wire to a small piece of anterior band material and the band material then being welded to the arch itself (Fig. 11 *B, C, D*). Care must be exercised in attaching these springs to the arch that either or both do not lose their resiliency.

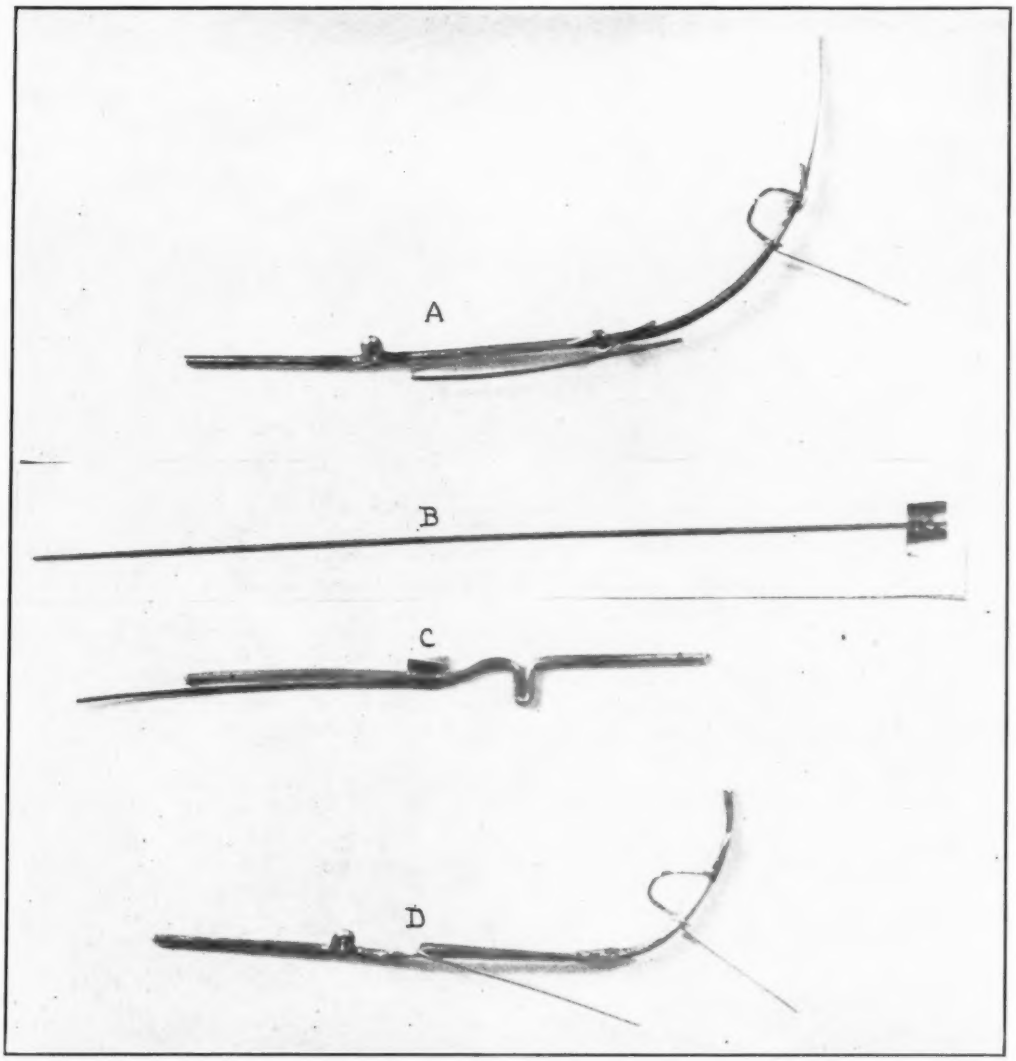

Fig. 11.—Springs attached to the arch wire by welding. *A*, Wrapped welded springs. *B*, Indirect welded spring, spring wire first being welded to 0.003 band material. *C*, Completed indirect springs. *D*, Band material is wrapped around arch wire and then welded to it.

LABIAL ARCH CONSTRUCTION

The arch can be constructed from sizes 0.036 to 0.020 wire. In the latter, all hooks, stops, etc., must be bent into the wire itself, as no attachments are possible; this lighter arch also requires considerable stabilization with bands and ligatures (Fig. 12).

A. *Attachments to the Labial Arch.*

1. *Soldered.*—Intermaxillary hooks of 0.028 and loop spring of 0.020 can be easily attached by soldering; flux both the labial arch and the spring wire, flow solder on each and then unite, taking great care not to overheat (Fig. 12).

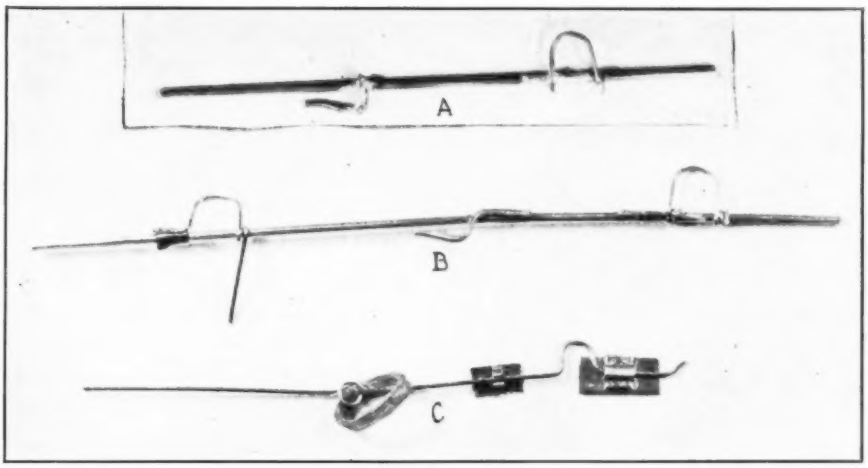

Fig. 12.—Labial arches. *A*, Attachments soldered to the labial arch. Note slight amount of discoloration at soldered joints. *B*, Attachments welded to the labial arch. Note the slight amount of discoloration at joints. *C*, The continuous labial arch constructed of 0.022 or lighter wire with stops, loops, and intermaxillary hooks bent of one continuous length of wire. Also shows the 0.022 snap channel and 0.030 buccal tube.

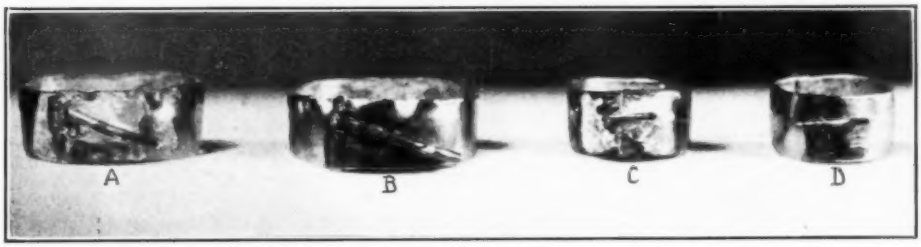

Fig. 13.—Spurs attached by soldering or welding. *A* and *C*, Soldered spurs. *B* and *D*, Welded spurs.

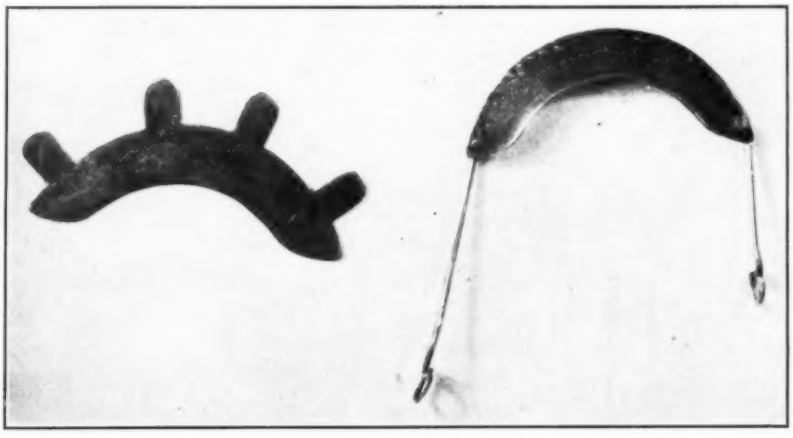

Fig. 14.—The Rocky Mountain Tru-form bite plane for attaching to the lingual arch. It may be attached flat or inclined.

2. *Welded.*—0.028 intermaxillary hooks and 0.020 U-springs can be attached by welding, using the indirect welded type or the wrapped type of attachment (Fig. 12 *B*).

SPURS AND INTERMAXILLARY HOOKS ON BANDS

These can be soldered or welded, care being taken not to overheat either the wire or the band (Fig. 13). Attachments are made as before described.

THE BITE PLANE

This can be either soldered or welded. The new Tru-form bite plane, made by the Rocky Mountain Company, comes ready to be adapted to the arch wire. It can be either welded so that there is a flat bite plane or welded in an inclined position. It must be welded twenty-five or thirty times along the anterior border to the lingual arch (Fig. 14), and care must be taken to prevent loss of springiness of the arch through burning.

CHROME ALLOY ATTACHMENTS

The flange, buccal, and oval tubes, the bite plane, McCoy open tube, snap channel, K-hook, etc., can be welded or soldered to precious metal bands; as can U-springs, intermaxillary hooks, plain and recurved springs made of chrome be soldered or welded to precious metal arch wires. It is also possible to solder or weld precious metal attachments and springs to chrome alloy bands and arch wires.

But the appliance entirely constructed of chrome becomes the ideal appliance. It has all the most desirable qualities: cleanliness, strength, inconspicuousness. It is not a cheap appliance—rather one in which true skill in manipulation is rewarded.

DISCUSSION

Dr. A. B. Brusse, Denver, Colo.—Dr. Bell has asked that I present something in the discussion pertaining to the chemistry and metallurgy of the new metals. I might say that most of us could not have been transported to this meeting in such comfort, speed, and safety if it had not been for the newer metals. The new high speed trains, like the Zephyr, attain their high speed and safety because with stronger metal they can be built lighter.

None of the automobiles could stand the punishment of a trip from New York to Hollywood fifteen years ago. High speed, light but very strong construction, noiseless engines, dependable brakes, all are gifts of the new metallurgical science.

The alloys used in automotive parts are in the very truth "new metals." These new metals are taking the place of precious metals in industry.

Contact points of molybdenum, one of the newer rare metals, have been installed by railroads, recently replacing silver which was formerly used for telegraph keys, signal relays, etc. They last fifty times as long and require less attention.

Contact points in automobile distributors are usually tungsten because it is harder and less costly. Formerly they were platinum. The tungsten points do as well and are cheaper.

Metals formerly considered rare are now being produced in sufficient quantities by the development of a new metallurgical technique.

Tantalum, tungsten, and columbium are very interesting metals and are alloyed with other metals by the new process "powder metallurgy." For example, the melting point of tantalum is excessively high. At that temperature it would combine with every other substance, and there would be nothing in which it could be molten. Therefore the metals are produced as a finely divided but crystalline powder precipitate from a fused electrolyte of

fluorides by an electric current. The purified powders are pressed into bars and heat treated by the passing of an electric current heating them by resistance. This has to be done under a high vacuum because of their affinity for the atmospheric and other gases. By a process of swaging and forging, followed by more heat treatment, they are finally caused to recrystallize into sound bars.

One of the great spectacular discoveries in metallurgical practice is the so-called "precipitation hardness," which, first noted in connection with duralumin, has been widely applied to other alloys and to ferrous metals, with outstanding results. These alloys after heat treatment and machining and working, when laid aside for a while, will grow in strength and hardness. This is called age hardening.

Beryllium is one of the lightest, hardest, and strongest of the metals. It is now obtainable in alloys with copper, to which it gives some rather startling properties.

In ferrous metallurgy, the development is so complex and rapid that it is hard to keep abreast of it. Many of the new products seem almost miraculous.

There are several thousand new alloys, and it is said that a well-informed metallurgist will know only a few of these and their properties. Therefore we, as orthodontists, cannot expect to be familiar with the new metals.

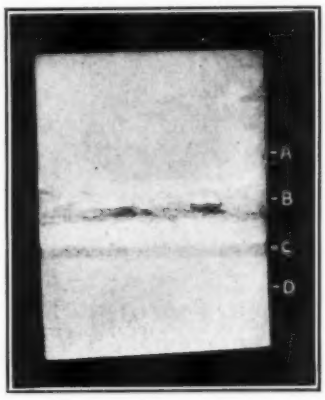

Fig. 1.—*A*, Piece of stabilized 18-8; *B*, welded joint; *C*, showing the precipitation of carbides in the nonstabilized steels; *D*, regular 18-8.

Alloys of chromium are better known in orthodontics. Up to the present time the most practical alloy is 18 parts chromium, 8 nickel, 0.15 carbon and molten mild steel. This product is known as Regular 18-8, or stainless steel. In Regular 18-8 the carbides tend to precipitate on long exposure to moderate heats. This makes the heated portion vulnerable to corrosion by removing the protective coating of chromium from the steel. This critical temperature is between 1200° and 1400° F., which is in the range of our soldering technique.

The United States Steel Corporation has developed a new 18-8 by the addition of titanium or columbium, which prevents or retards the migration of carbides to the grain boundaries. This process is called stabilization. I have had several experiences of corrosion in the mouth with Regular 18-8 but none with Stabilized 18-8.

Fig. 1 represents a section of welded steel. Stabilized 18-8 has the orthodontic requirements of special properties in a high degree; viz., hardness, tensile strength, and elasticity.

From its plastic state it can be cold worked to a surprising degree of hardness, which is valuable in band technique. Most any degree of tensile strength can be secured up to 300,000 pounds per square inch, depending on the number of times drawn after annealing.

It has two supposedly undesirable qualities: it cannot be heat treated, and it is difficult to solder. It is therefore necessary to perfect one's technique to prevent annealing.

Difficulty in soldering has proved a virtue because it has brought to us the art of electric welding, which not only is fascinating but is a timesaving device.

High heats are necessary for welding two pieces of metal together, and in spot welding the heat is generated by the resistance to the electric current. Chrome alloy is highly resistant to the electric current; therefore it is an ideal metal for spot welding.

Dr. Bell has demonstrated the successful use of the soldering technique, but my choice is the spot welding, because it is cleaner, quicker, and more positive.

For those who have ridiculed and called it the "scrap-iron" technique, I should like to call to their attention the usage of this metal in surgery. It is used as sutures to a portion of the braincase after fractures or operations, and these metals are left in permanent contact with the delicate tissues of the brain. In fractures of the hip, three pins, which are no more than Stabilized 18-8 screws, fasten the fractured portions together and are left permanently in cases of older people.

Formerly, in the hospitalization of a case without these pins, the patient was in a plaster cast from eight to ten months. By using the pins, the patient is in a wheel chair within three or four weeks.

After seeing chrome alloy applied by different operators with different techniques, I am thoroughly convinced that chrome alloy is a real contribution to orthodontics.

Dr. George H. Herbert, St. Louis.—The one phase of the use of chrome alloy that I wish to discuss is that of *welding*. As to soldering, I have tried it and found that welding was so much better and easier to do, with nicer joints and less polishing, that for the last four years I have done no soldering.

Chrome alloy is not an easy metal to handle and control at the beginning, especially, for those who have used gold alloy or base metals in their practices. It is much springier than the other metals, and that is a great advantage; for we can use much smaller gauge wire and thinner bands to obtain the required pressure, and that gives us a less bulky and much neater appliance. The tissues also tolerate it better than any other metal I have used.

Now for the man who wishes to begin using chrome alloy and to weld it: If he will remember a few essential points that must be given consideration and then have patience, and practice time after time and not expect the first to be as good as he can do with his other alloys, but believing that later on it will be better than the others are at present; if he will do this, he will be rewarded in time saving and satisfaction. This satisfaction cannot be realized until he later has the opportunity of comparing some of his former appliances of other alloys with some of his present appliances of chrome alloy.

I am not radical and never have been in changing from one method or one appliance to another, but I have always tried to keep an open mind and grasp the opportunity to do something better and do it easier. I believe I have been rewarded more by mastering the welding of chrome alloy to the point that it is easier for me to obtain the desired results by using it, than by any other change I have made.

Now for the few essential things:

First, select the wire and attachments you wish to use. There are many on the market now, as there are many golds on the market. Before I began using chrome alloy, I selected Dee's gold and used nothing else for many years before I started chrome. I learned to know my product and to depend on it, and now I am the same way with Rocky Mountain materials in chrome, and I use it exclusively. *Pick your materials,* that is most important. You must have good materials.

Second, you must have instruments that will stand up under the use of chrome. Do not try to use the same cutting instruments that you have used on gold. You will get used to using the welder the same as you did your pet burner when you were soldering. Then do not be afraid to practice until you learn to obtain the desired results. Do not be afraid to give a clinic or two; show the other fellows. For that also helps the one who gives the clinic. When I had been using chrome only a short time, I gave a clinic at the national meeting in New Orleans; and I remember very well that I made about 40 lingual wires at that clinic, and after that it was much easier for me to make lingual wires. Chrome alloy is practical in an orthodontic practice; it is not an experiment for it has proved its worth to those who have patience to master the technique of using it. It makes possible cleaner mouths with less effort for the patient and better results with less effort for the orthodontist.

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ANODONTIA

A REVIEW OF ITS ETIOLOGY WITH PRESENTATION OF A CASE

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FRED ROTHENBERG, DR. MED. DENT., D.D.S., NEW YORK, N. Y.

THE anomalies of the teeth have always been of great interest to the dentist from the scientific as well as the practical viewpoint. Patients and parents come again and again to the dentist and request treatment for anomalies such as supernumerary teeth, deficiency in the number of teeth, retention, or impaction.

This paper will be concerned throughout with one special kind of anomaly, i.e., the deficiency of teeth, called anodontia.

There are two large classes of anodontia, partial and total. A classification into a true and a false deficiency is not correct since the false deficiency represents no deficiency at all, but might be a case of retention, impaction, malposition, or some other abnormality. Also, on the other hand, cases of incidental removal of a tooth germ during the extraction of a deciduous molar cannot be considered as belonging to the class of true deficiency.

It is difficult, however, always to recognize such cases of incidental extraction. The statements of older persons as to a partial or total anodontia must not be taken for granted in most cases, as they may tell tales because of false impressions or to create sympathy. Reports on deficiency written before the time of x-rays and reports which are not proved by roentgenograms must also be handled very skeptically and cannot be used for any statistical purposes.

It is absolutely necessary to undertake a thorough roentgenographic investigation to determine true anodontia. A health report and the family history are of great help because very often the etiology of the deficiency is detected by that means. The condition of alveolar ridge may dispel doubts in many cases of true anodontia, because it usually is smaller where there is true anodontia than where teeth are present. Many times it is only a few millimeters wide (underdevelopment of inactivity).

A true deficiency exists only in cases where neither retained tooth germs nor their developed forms can be identified by x-rays. It also exists where

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the age of the individual accounts for the presence of the necessary number of teeth and where an early extraction of the missing teeth does not agree with the age of the patient.

Groeschel, who made a survey of the literature on anodontia in 1931, found 107 cases reported. He believes the etiology is still vague and thinks there are various causes for the disturbance. Dolder published in 1936 a statistical survey about deficient dentition. The mouths of 10,000 school children from 6 to 15 years old were examined by him at the school dental clinic of Berne, Switzerland, for evidence of supernumerary or congenital absence of teeth. The presence of third molars, however, was not studied. These are his conclusions:

1. Three hundred forty children (3.4 per cent) had congenital absence of teeth, 709 tooth germs (7.45 per cent) were absent, an average of two in each affected child.

Fig. 1.

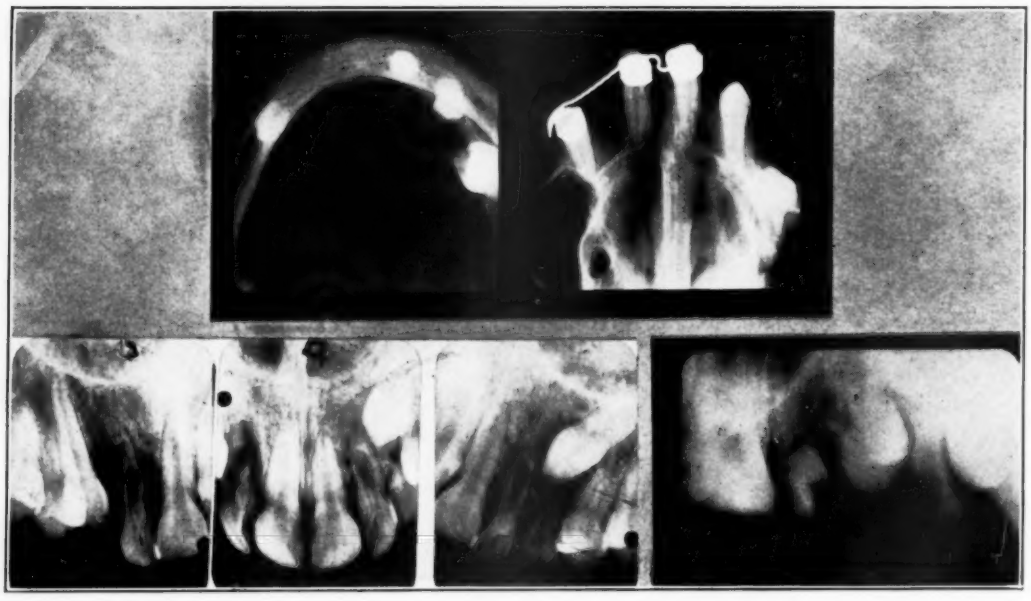

Fig. 2. Fig. 3.

Fig. 1.—Case of partial anodontia.

Fig. 2.—Case of odontolysis in young patient. When this tooth was exfoliated and the patient was examined by another practitioner, the case was classified as one of anodontia until history was checked.

Fig. 3.—Case where infected deciduous teeth had been extracted and a permanent tooth bud had been partly exfoliated. This could very possibly be diagnosed as partial anodontia, if the history of the case were unknown.

2. Thirty-two children (0.3 per cent) had supernumerary teeth, there being thirty-six such teeth in all.

3. There is thus one child with excess teeth to ten with deficient dentition. For one supernumerary tooth there are twenty missing teeth. This suggests that the modern dentition is tending to a reduction rather than an increase.

4. Of the 340 cases where the dentition was deficient, 44 per cent had one tooth, 36 per cent two teeth, and about 20 per cent from three to eleven teeth missing.

5. Absence of teeth was observed more frequently in the mandibular than in the maxillary jaw (7 to 6) and excess occurred more often in the maxillary than the mandibular jaw (5 to 1). There was no difference between the right and left side.

6. The frequency of deficient dentition, in regard to the individual tooth germs, is as follows:

Mandibular second premolar	47.3 per cent of affected cases
Maxillary second premolar	25.3 per cent of affected cases
Maxillary lateral incisor	12.3 per cent of affected cases
Maxillary first premolar	5.5 per cent of affected cases
Mandibular first premolar	3.0 per cent of affected cases
Mandibular central incisor	2.2 per cent of affected cases
Maxillary canine	1.8 per cent of affected cases
Mandibular lateral incisor	1.1 per cent of affected cases
Maxillary second molars	0.8 per cent of affected cases
Mandibular second molars	0.7 per cent of affected cases

No first molars, mandibular canines, or maxillary central incisors were absent.

7. There was no difference in the general incidence in the two sexes, but the absence of the maxillary lateral incisors was more common in girls and that of the maxillary second premolars in boys.

8. In eighteen cases (5 per cent) familial distribution on the dental deficiency was observed, an indication that the part played by heredity is important.

A similar survey was made in the Children's Department of the Dental School of the University of Pennsylvania. In the years 1935-36 and 1936-37, 1,000 children from 3 to 15 years of age were examined and treated. Any abnormality in regard to children's teeth was recorded and, if possible, investigated further. The results were as follows:

1. Twenty-three children had congenital absence of teeth (2.3 per cent); sixty-three tooth germs were absent, an average of nearly three in each affected child.

2. Sixteen children (1.6 per cent) had supernumerary teeth, there being twenty such teeth in all.

3. Seven children (0.7 per cent) had supernumerary and congenitally missing teeth. The seven children are already included in the numbers of the two previous paragraphs. For one supernumerary tooth there are three missing teeth.

4. Of the twenty-three cases where the dentition was deficient, 40 per cent had one tooth, 45 per cent two teeth, 5 per cent three teeth, and 4 per cent five or more teeth missing.

5. Absence of teeth was observed more frequently in the maxillary jaw (15 to 5) and in three children absence occurred in both jaws with excess of teeth more often in the maxillary than in the mandibular jaw.

6. The frequency of deficient dentition in regard to the individual tooth germ is as follows:

Maxillary lateral incisor	38.5 per cent
Mandibular second premolar	14.5 per cent
Maxillary second premolar	14.5 per cent
Mandibular lateral incisor	6.5 per cent
Maxillary canine	6.5 per cent
Maxillary first premolar	3.0 per cent
Mandibular canine	3.0 per cent
Mandibular central incisor	3.0 per cent
Maxillary second molar	3.0 per cent
Mandibular second molar	3.0 per cent
Mandibular first premolar	1.5 per cent
Maxillary first molar	1.5 per cent
Mandibular first molar	1.5 per cent

7. Congenital absence of deciduous teeth occurred only in one case. Thirty per cent of all cases had other abnormalities and anomalies besides congenital absence or supernumerary teeth.

8. The incidence of congenitally lacking teeth was nearly equal in both sexes (11 to 12). For supernumerary teeth it was more often observed among the boys (10 to 6).

The most striking result of these investigations, conducted in two different countries, even in two different continents, is that Dolder found a 3.4 per cent incidence of congenitally missing teeth and the investigators in Philadelphia only 2.3 per cent. An explanation for this rather great difference may be found in the high occurrence of thyroidism in Switzerland. The Alpine mountain region of Southern Europe is one of the most noted of the endemic goiter districts. In North America the most noted region is the entire basin of the Great Lakes, the basin of the St. Lawrence, the States of Colorado and Utah, and that portion of the United States and Canada, known as the Pacific Northwest. The incidence of goiter in the state of Pennsylvania is a very low one compared with that in Switzerland. Hutton says that of all the endocrines the thyroid apparently plays the most important role in the dentition. Its deficiency in infancy is accompanied by delayed and irregular eruption of the teeth, with consequent irregularity in their size. The teeth are also of poor quality and prone to early decay and loss. The deciduous teeth are slow in erupting, and they may be retained beyond the usual age with consequent delay in the appearance of the permanent teeth.

Various reports on partial anodontia have been found in the literature during the past few years and a number of them will be presented here:

McPhail reported an 11-year-old girl with congenitally missing maxillary lateral incisors. There was no further history to the possible etiology of the anomaly given, and the case was treated orthodontically.

Thiel reported a case of partial anodontia in a 16-year-old girl who otherwise was healthy and normal. The only other abnormality was that her hair started to grow at an age of 8 years and was very thin. The following teeth were missing: $\frac{765\ 32\ |\ 23\ 567}{765432\ |\ 23\ 567}$.

Sly wrote about a case of partial anodontia in a 12-year-old girl. The following teeth were absent: $\frac{2\ |\ 2}{5\ |\ 5}$. In her younger sister both maxillary lateral incisors were missing. Both girls were physically and men-

tally normal. He discussed the case from an orthodontic standpoint and did not mention anything about the dental conditions in other members of that family.

Kalvelis reported a case of partial anodontia in a 9-year-old girl. The following teeth were missing: $\frac{5432 \mid 2345}{54321 \mid 12345}$. The patient never had osteomyelitis. She had normal ectodermal organs. The author does not give any comments whether this anomaly is inherited from the parents or some other part of the family. The jaws have a normal size.

Porter gave a case of partial anodontia in a 13-year-old girl who had twenty-nine teeth missing. Six other members of that family were normal. Her 15-year-old brother had sixteen teeth missing. The girl was very small, 4 feet 7 inches.

McCoy reported a case of a 15-year-old girl whose maxillary incisors were congenitally absent. He assumed that this anomaly was inherited, but he could not bring any proof thereof. He reported this case because of its interest from an orthodontic standpoint.

Moore wrote of a 6½-year-old girl whose mandibular left lateral incisor was congenitally missing. No anomaly of dentition was known to be present in the father and mother or any relatives. This case also was presented with regard to its orthodontic treatment and problems.

The clinical findings in people suffering with anodontia vary in every case. The head may show certain characteristics, unusual contours, prominent supraorbital ridges, broad flattened nose, and thick lips. The hair is most frequently involved. Hypertrichosis is seen in another type, the so-called hair-man, a retention of the lanugo of postembryonic life, a pseudohypertrichosis, may be present. The best known case of the last type is that of the Russian "poodle man," Adrian Jeftichejew, and his son, Feodor. The father had in his maxilla only one canine, which at the end of his life was practically a peg tooth, but his mandible was better equipped. The son's maxilla was quite toothless and the mandible contained only the incisors.

Thoma claims that in cases of complete anodontia of the deciduous as well as the permanent teeth the mandible will develop to its normal size. The same is true in those cases where the teeth were fully formed but unerupted and impacted. The mandible fails to develop and remains considerably undersized in cases of early acquired ankylosis with muscle function reduced to a minimum. The development of the mandible seems therefore to be influenced principally by muscular function and its associated increase in collateral blood circulation. He proves his theory with roentgenograms and photographs of cases with complete anodontia and of cases with an early acquired ankylosis. The maxilla does not seem to be dependent to a great extent on the function of the masticatory muscles for its development and growth. The controlling growth factor for the maxilla appears to be, according to Thoma, nose breathing through its effect on the pneumatic cavities and the blood supply of the bone.

The number of teeth in the human denture seems in general to be constant with twenty deciduous teeth and thirty-two permanent teeth. Very

seldom has a marked deficiency been observed in the deciduous denture. It may be attributed to the fact that the deciduous denture is the more constant element and that destructive diseases during the first or second month of embryonal life, which would cause a destruction of the deciduous tooth germs, would in such an early stage endanger the life of the mother or would cause marked malformations in the ovulum.

The deficiency of teeth is found more often in the permanent denture. It occurs with such regularity that it leads to the belief that it results from a well-determined reduction. In most cases the maxillary lateral incisors, the mandibular central incisors, the maxillary second premolars, and the maxillary third molars are missing, either separately or in any combination at the same time.

Fig. 4. Fig. 5.

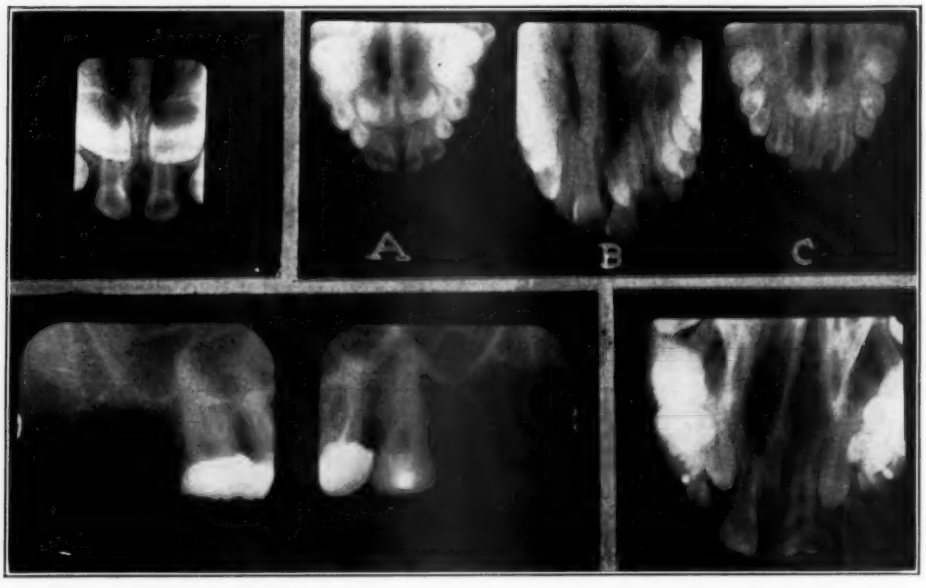

Fig. 6. Fig. 7.

Fig. 4.—Congenitally lacking lateral incisor in mouth of child, 3 years of age.

Fig. 5.—*A* and *C*, Supernumerary deciduous teeth. *B*, Supernumerary tooth in permanent dentition.

Fig. 6.—Congenitally lacking third molars in mouth of female dental graduate, fully aware of her dental history.

Fig. 7.—Case of congenitally lacking lateral incisors.

Formerly, according to evidence presented, it was believed that a lack of individual tooth germs was a sign of general physical degeneration. Today it is considered by many writers to be a retrograde development in which the number of teeth is decreasing to conform to the needs of mastication of this era of human development. On the contrary the often observed supernumerary teeth are believed to represent an atavistic reversion.

The theory of reduction is supported by the following reasons:

Man in his earliest stage of development is supposed to have had a larger number of teeth than he has at present. Some of these teeth have been lost during his course of development. This cycle has not been completed yet.

Formerly the tooth formula was 3413 | 3143; it means 3 molars, 4 premolars, 1 canine, 3 incisors, 3 incisors, 1 canine, 4 premolars, 3 molars. Today it is 3212 | 2123, and the future formula will probably be 2111 | 1112, if the process continues. This forecast originates from the often observed lack of the germs of the maxillary lateral incisors and third molars.

Some very interesting observations have been made recently in regard to the third molar. Hellman stated that there is a trend in human evolution to suppress the third molar teeth and that this occurs in two ways: one is by delaying their eruption indefinitely and the other by eliminating them entirely. In his studies on skulls of nineteen different races and nations, he found missing third molars to the extent of 2.6 per cent in West African negroes and up to a 49 per cent incidence in Europeans (Hungarians). He examined 1,049 skulls with one to four third molars missing in 29.65 per cent and one or two third molars missing in 18.97 per cent. Among 433 students of the Dental School of Columbia University 25.40 per cent had one to four third molars missing and 19.16 per cent had one or two third molars missing.

Euler, who conducted a similar study on skulls of prehistoric men, came to quite a different conclusion, which is interesting. He found an incidence of 26.83 per cent missing third molars in prehistoric man, but among the 150 students of the Breslau Dental Institute, only an incidence of 1.33 per cent. He does not, therefore, believe that the human denture has been developing toward a reduction in the number of molars.

Adloff, however, found in similarly conducted researches an incidence of 1.17 per cent missing third molars in 170 skulls of Melanesians which may be considered as normal when compared with the 2.6 per cent found among negroes in Hellman's research. Consequently the "normal" denture of today is considered to present only a certain stage of this phylogenetic process of development. The forecast that the man of the future will be edentulous is, indeed, too fantastic. Even though civilized man does not use his teeth as hard as his ancestors did, it is doubtful whether he will ever be able to do without them.

It can be said, however, that the studies of Hellman, Euler, and Adloff covered only a range of time of not more than 5,000 to 10,000 years at the most. This is only a very short time for phylogenetic developments which will become finally so fixed that the feature will be inherited and dominant. More than ten times as many years have to pass before any change of development may become dominant enough to occur in a great percentage of human beings. The results of these studies cannot, therefore, be considered to be a proof for the theory of reduction in the number of the teeth of the human dentition.

William Bateson brought forward a theory which, as believed by the authors, presents so far the best explanation for the occurrence of supernumerary, as well as congenitally absent, teeth. He published this theory for supernumerary and congenitally absent organs as early as 1894 in his book, *Materials for the Study of Variations.* R. C. Osburn related Bateson's theory

to the study of supernumerary teeth in the human dentition in 1912. G. V. Black in 1909 presented a discussion of the theory on supernumerary teeth and also rejected the reversion theory at that time. He was apparently unaware of the work of Bateson though his theory fitted in generally with the study and conclusions of Bateson.

Supernumerary teeth in the human dentition are recorded as a third maxillary central incisor, a second upper canine, a third premolar, or a fourth molar. As quoted by Diamond in his book, *Dental Anatomy,* Bateson explained such supernumerary parts, as fingers, toes, ribs, vertebrae, or teeth, as "meristic" or numerical variations, which the serial structures are especially liable to. His studies included a wide range of animals, but they did not include the human dentition. Osburn related it to the human dentition and summarized the theory as follows:

"1. A third premolar, a third incisor, or a fourth molar in man could be accounted for as atavism only by a reversion covering so long a period of time that this alone is sufficient to render the theory untenable in the light of our modern knowledge of heredity.

"2. A second cuspid in man or lower mammals cannot by the remotest possibility be due to reversion since there is no ancestral condition to which it could revert.

"3. Supernumerary teeth seldom present characters which, by any stretch of the imagination, could be called atavistic. They may have a conical form or be otherwise rudimentary or vestigial, but they do not present ancestral character.

"4. Duplicate teeth often occur, either in or out of the series, and are so similar to those normally present that it is impossible to state which is the supernumerary tooth. Such teeth are not atavistic in character, and it is futile to attempt to explain them as such.

"5. The paleontological record of the evolution of the teeth in all mammalian orders lends no support to the theory of atavism as applied to supernumeraries."

Supernumerary teeth are most frequently found at the beginning or the end of the posterior series, but they also may be found in the middle or at any point in the series.

Numerical variation in the dental series may be bilaterally symmetrical, but much more often it is not. Symmetrical variations may occur on both sides of the same jaw, one side of both jaws, or on both sides of both jaws, but it is always rare.

Black offered an embryologic explanation for the occurrence of supernumerary teeth. The rods of cells, which arise from the dental lamina and which give rise to the enamel organs, are by no means always limited to a single proliferation for each tooth of the normal series, but accessory rods are often observed.

Leche and Roese (quoted by Diamond) advanced the theory of an accidental splitting of a tooth germ so that two teeth develop from a single germ.

Supernumerary teeth are therefore ontogenetically determined and are phylogenetically perpetuated according to the Mendelian laws and have no ancestral heritage.

The congenital absence of teeth is also characteristic, phylogenetically, of serial structures. Osburn says (quoted by Diamond) that teeth may be omitted from any part of a series, a fact for which reversion offers no explanation, but which can be explained by the theory of variation of serial structures. Bateson characterizes them as discontinuous variations.

The congenital absence of teeth may also be explained on an ontogenetic basis in terms of atrophic degeneration. Similarly there may be a partial atrophy of epithelial rods, producing underdeveloped teeth like the conical or peg-shaped lateral incisors. They are all found to be phylogenetically perpetuated or inheritable.

Willner published a fairly complete report of cases illustrating deficiency in the number of canines. He concluded that the complete absence of permanent canines must be regarded as an extremely rare phenomenon. It is nearly always combined with anomalies in the number of the other teeth. Just recently Lubner reported a case of a boy, aged 7 years, in whom both maxillary permanent canines were missing. No trace of them could be found in the antra, air sinuses, or in the nasal fossa. According to the report, all other teeth seem to be present or formed in the jaws.

Thompson reports a case of a 17-year-old girl with both mandibular canines congenitally missing. No further history was given, and the case was discussed from its orthodontic standpoint.

Many cases of deficiency in the permanent dentition are preceded by an absence of the corresponding deciduous teeth. On the other hand, there are cases observed in which despite a complete absence of the deciduous dentition which is very rare, a permanent dentition has appeared from the sixth year onward.

Busch also observed that the presence of a deciduous dentition is not necessarily followed by the development of the corresponding permanent teeth. For example the lateral incisor is very rarely absent in the deciduous denture but very frequently in the permanent. It is quite common also for the mandibular deciduous central incisors to have no successors.

TOTAL ANODONTIA

A differentiation is made between partial and total anodontia. Partial anodontia, as we have seen, means lack of one or more teeth, either in the deciduous or permanent dentition, or in both. Total anodontia means complete absence of the deciduous and the permanent dentitions or of either of them. The following cases have been reported:

Herbst describes the case of a woman who had neither her deciduous nor her permanent teeth. Both her daughters had very underdeveloped dentures. It must be assumed that the woman had a complete aplasia of the dental lamina.

Zilkens reported in 1927 a case of a man 25 years old who, except for two odontoid formations, one on each side of the molar region in the maxillary jaw, possessed no teeth at all, not even retained teeth. There were developmental disturbances of the hair all over the body and of the nipples. Also the second and third toes of the left foot were adherent.

Fig. 8.

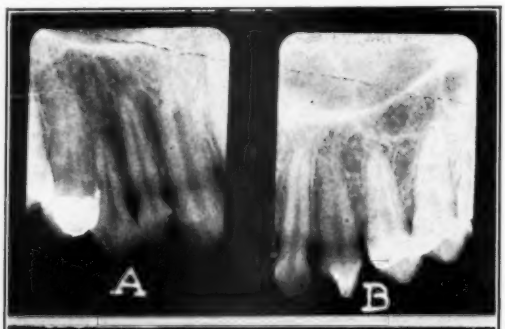

Fig. 9.

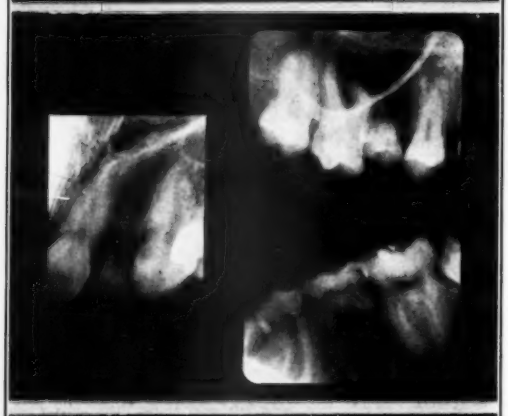

Fig. 10.

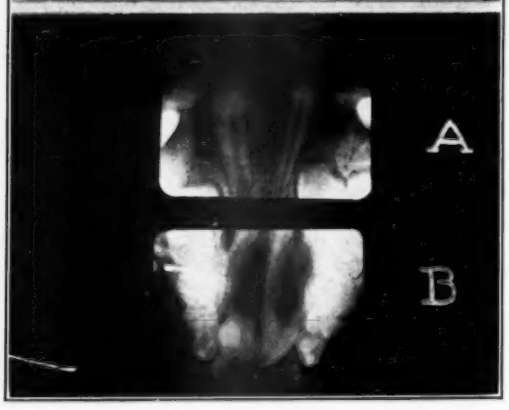

Fig. 8.—*A*, Congenitally lacking maxillary permanent canine. Retained deciduous canine. *B*, Maxillary canine on the opposite side of the jaw of the same patient. Clinically this tooth resembled a supernumerary tooth.

Fig. 9.—Congenitally lacking permanent teeth with retained deciduous teeth.

Fig. 10.—*A*, Congenitally lacking mandibular first permanent incisors. One deciduous incisor is still present.
B, Deciduous lateral incisors present, one permanent lateral incisor lacking.

Guildford reported a case of a 48-year-old man who was edentulous from birth. The case was published in 1883 and, though there could not have been any x-rays taken, one can be rather certain of the statements of Dr. Guildford, at that time professor of operative dentistry in the Philadelphia Dental Col-

lege. The patient, born in Pennsylvania, never perspired, had no sense of smell, was almost devoid of taste, and had never been confined to bed by sickness a day in his life. There were no fine hairs that usually cover the body. His head was sparingly covered with the soft downy growth characteristic of early childhood. His skin was always dry, more so in the summer than in winter. His maternal grandmother never had hair or teeth. Her daughter, his mother, was normal but she had a brother who was edentulous and hairless. His mother had given birth to twenty-one children, eighteen of whom lived to adult life. Several sons were lacking certain teeth. The man himself is the father of eight children, some of whom have a limited number of teeth but are normal in other respects.

At a meeting of the Odontological Society of Great Britain, Mr. Rushton showed models and photographs but no x-rays of an Armenian boy, aged 16 years, who had no teeth, either first or second dentition. The father and the mother were both normal. When the child was born, he had no hair, and, when examined sixteen years later in 1904, his hair was soft and white resembling wool.

In 1936 Battersby reported a case of complete absence of the first and second dentition in a boy about 9 years of age. His head was well covered with fine light-colored hair. He could apparently masticate all foods with his gums. There was no evidence of rickets, in fact, no evidence of any other organic diseases. X-ray films showed a complete absence of teeth or rudiments of the teeth. There was a well-pronounced alveolar ridge and the palate was flat with marked rugae. The anomaly was supposedly inherited from the mother who lacked the following teeth $\frac{2 \mid 2}{21 \mid 12}$. Her father and great-grandfather had only eleven teeth of the second dentition spaced, and distributed between maxillary and mandibular jaws. There was no first dentition. The father of the boy was normal and his only brother, 11 years of age, was also quite normal. The boy cannot stand much exposure. Only his hands and feet perspire, and he has to go indoors in order to cool off. The coincidence of the lack of teeth and the failure to perspire due to absence of the sweat glands or their lack of ability to regulate the internal heat to the external heat, tends to prove again the fact that in congenital ectodermal dysplasia very often several other ectodermal structures of the skin are not developed, as shown in this case, in Guildford's case where the sweat glands and sebaceous glands were not formed, and in the case presented by Rushton where disturbances of the hair were present.

Nager published a case of complete anodontia in a 24-year-old boy whose hair was very thin. He had a normally developed mandible and an underdeveloped maxilla. He had no sweat glands but was normal otherwise.

Warr reported a case of complete absence of the permanent denture in a 12-year-old boy. The maxillary lateral deciduous incisors were missing also. The boy is normal in all respects. The parents were first cousins, but there was no history of any dental peculiarities on either side of the family. This case was treated prosthetically.

The writers have never observed any total cases of anodontia, but have treated several severe cases of partial anodontia.

PARTIAL ANODONTIA FROM EXOGENOUS AND ENDOGENOUS CAUSES

The causes for the partial deficiency according to findings can be classified into four large groups:

1. Local influences in the direct region of the jaw.
2. Constitutional diseases.
3. Trophoneurotic and endocrine disturbances.
4. Inheritance.

It is evident that acute and chronic inflammation of the jaws, pyogenic inflammation of the tooth or of the socket, and similar local diseases are able to destroy the tooth germ. Osteomyelitis at an early age can cause the expulsion of tooth germs. Deficiency has been observed and reported, too, in

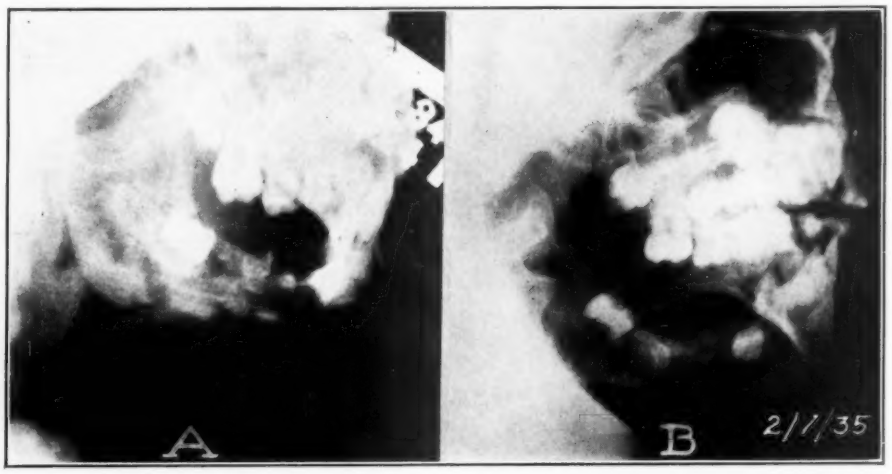

Fig. 11.—*A*, Case of ostecmyelitis in 5-year-old child, causing loss of deciduous teeth and permanent tooth buds.
B, Same case, about one year later, which may be difficult to diagnose in later life and might be classified as anodontia.

cases of malformation of the jaws, such as cleft palate, micrognathia, and macrognathia. Tumors and swellings as odontoma and sarcoma may also displace neighboring tooth follicles and cause atrophy. Partial anodontia may also be caused by destructive inflammations of the tooth follicle and by follicular cysts. X-rays and radium may cause a disturbance of the germ because they retard growth of tissue and may even lead to a complete destruction of the germ. Birth trauma, which may occur with the use of forceps, may result in resorption of the deciduous tooth germs.

Hoepfel made some study on stillborn babies and found in all cases a considerable amount of hemorrhage in the tooth germ which may cause future trouble, as deformities, malposition, and even atrophy due to pressure in the tooth germ.

We may think also of birth trauma and the subsequent changes in the pituitary gland that may be so extensive that they cause an endocrine dis-

turbance. The venous drainage of the hypophysis is closely connected with the venous drainage of the brain which is often exposed to birth injuries with all head deliveries.

All kinds of diseases are held responsible for partial anodontia. Ewald mentioned a report of a case of partial anodontia caused by scrofulosis. Loos described a case in which a partial deficiency was caused by tuberculosis. Frequently rickets is considered a cause of deficiency. Quinby describes the case of a boy, 7 years of age, with partial anodontia. The child was born prematurely, a seven-month baby, and immediately after birth developed rickets, of which he was cured by proper diet by the time he was three years old. The child had the following tooth formula: $\frac{5\ \text{CB} \mid \text{C}\ 5}{}$. X-ray examination showed no permanent teeth or tooth buds whatsoever except one which appeared to be the maxillary right canine forming over the right deciduous lateral incisor. The ridge in the mandible is not over 3 mm. high.

Also scarlet fever, where the *Streptococcus pyogenes* is believed to produce a strong tissue-destroying acid, was reported to be a cause of partial anodontia. From the viewpoint of Kantorowicz it is certain that congenital syphilis has an influence upon the tooth germs in their development and may produce characteristic changes in their shape. Since congenital syphilis may noxiously affect the osseous tissues in the form of chronic inflammations even during fetal life, anodontia often results because development of the tooth germs can be retarded by inflammation in the jaw region. It is not supposed to be the local influence of the *Spirocheta pallida* upon the tooth germs but the virus of the spirochetes which produces endocrine disturbances. In Campbell's paper about missing maxillary lateral incisors, he reports that in the literature a total of seventy-five cases are reported as personal observations by writers who regarded the lack of lateral incisors as resulting from syphilitic heredity. Campbell observed thirty-five cases of missing lateral incisors out of a total of 2,000 patients (1.75 per cent) examined over a period of thirty years in his office. Though he does not want it understood that he considers every individual with missing lateral incisors necessarily a second or third generation hereditary syphilitic, he does believe that it is difficult to exclude the possibility of an original syphilitic injury to the incisor region. The injury may ultimately become a dominant inevitable character and be handed down for numerous generations. The same author in a recently published paper found that in certain cases the maxillary lateral incisors were congenitally absent in the offspring of a syphilitic parent. But these teeth were absent also in children whose parents had Hutchinson's teeth. It appeared to be one of the many dystrophies that occur further along the genealogic line from original syphilis. He gives eleven cases of malocclusion and dental anomalies, and in all of these he has known something of the family history; there was not one which did not show dental abnormalities on at least one side of the family in the preceding generation or generations. He draws the conclusion that injuries to the teeth in families with a syphilitic background do not disappear with the generation showing heavy markings, such as Hutchinson's teeth, but tend to reappear usually in decreasing intensity in children and grandchildren.

Frahm reports one case of partial anodontia with a history of syphilis in both parents. The patient was a girl who had some deciduous teeth and only four permanent teeth in each arch.

A nutritional disturbance such as undernourishment of the mother during pregnancy can also affect embryonal formation.

OTHER SYMPTOMS ASSOCIATED WITH ANODONTIA

It is a fact that the deficiency in the human denture often coincides with strange changes of the hair, nails, and skin glands. Hypertrichosis, onychauxis, and anhydrosis may occur at the same time. There is a close relationship between deficiency of the teeth and the amount of hair. It is known that the teeth as well as the nails, hair, and skin glands are epidermoid formations and are derived from the ectoderm. They are subject, therefore, to the same conditions of nourishment and to the same diseases. A coexistent overproduction of hair with a deficiency in the number of teeth was explained by the hypothetical theory that the ectoderm possesses a certain amount of growth and developmental energy which was exhausted by the excessive growth of hair, and thus the development of the other ectodermal formations was retarded or even stopped. A later theory, however, states that in certain hairy people an overproduction of the normal hairiness does not exist, but on the contrary there is a persistence of embryonal conditions of the ectoderm which affects the dermal appendages, as well as the formation of teeth. Usually the first hair formed in utero is soft and silky, called lanugo. Normally this hair falls out shortly before or after delivery. In some cases of anodontia slight hairiness was observed while the sweat glands were missing. In one case even the olfactory sense was lacking. Therefore, the theory of the persistence of the formation products of the ectoderm seems to be more plausible because of the presence of the lanugo, total or partial deficiency of the teeth, embryonal structure of the skin, and the lack of sweat secretion. These peculiarities were found to be central disturbances in the normal development of the ectoderm at a very early stage of embryonal life.

Miller describes a case of partial anodontia in a 13-year-old Italian girl who had achondroplasia. There was complete absence of the following teeth: $\frac{8\quad 2\ |\ 2\quad 8}{8\quad 21\ |\ 12\quad 8}$. The mandibular canines, premolars, and both the maxillary and the mandibular second molars showed marked developmental disturbances and were not erupted. The maxillary incisors had a bizarre, conical shape. One of the authors had already observed this case in the dental clinic of the Children's Hospital of Philadelphia.

The cause of anodontia may be a disturbance of the endocrine glandular system which brings about a retarded formation of the ectoderm and explains, therefore, the simultaneously appearing anomalies of the teeth, hair, and sweat glands. It is not always one special gland which will cause such an effect but the polyglandular system which may be involved. The glands

which may be of importance in influencing these anomalies are the thyroid, the parathyroid, the thymus, and the hypophysis. Besides, Robinsohn claims that recently he found endocrine glands in the epithelial rests of Malassez in the peridental tissue. He even supposed that a net of endocrine glands is present, scattered all over the body. This, however, has not yet been supported by research results.

A deficiency of the teeth was observed in patients in whom the function of the thyroid gland was disturbed and the thymus was missing. In cases of different types of cretinism, retarded dentitions and the lack of individual teeth or even of whole rows of teeth was noted by Steeves. Disturbances in the function of the hypophysis, the parathyroid, and the thymus cause disturbances in the tooth system. Whether these endocrine disturbances are primary causes, or whether they affect a primary malformed germ or organs with decreased growth energy, has not been proved as yet and needs further investigation.

HEREDITY

It is a well-known fact that tooth anomalies are hereditary. Some anomalies of the jaw and bite are dominant in inheritance. General disturbances of the ectoderm are also hereditary. Several authors stated that this anomaly affects the male only. Daughters, supposedly, are not affected by the anomaly but act as so-called carriers, as in the inheritance of hemophilia, i.e., their sons show malformations again even if the father is normal. There are, however, many exceptions to this rule which they explain in this way: that in the case of a female the anomaly is not a hereditary one but depends on different causes and influences. But the report of cases of anodontia in females with only one parent affected may show that the afore-mentioned course of heredity does not always happen.

Ritter, who did a great deal of research work about the heredity of anomalies of the jaws and the teeth in dogs and on identical and fraternal twins, found a number of congenitally missing teeth and supernumerary teeth in twins, identical as well as fraternal. He found a difference in the occurrence of the anomaly in either member of identical twins which surprised him very much because the quality and quantity of the gene of both partners were alike. He believes, however, that anodontia can be inherited. A dominant heritage can be assumed, but the quantity of the determinant factor is influenced by considerable variations and fluctuations. He did not find a reasonable explanation for the occurrence of different anomalies in the identical twins.

Gray reports a case of a 9-year-old boy who had six deciduous teeth and thirty permanent teeth missing. The shape of the head suggested a mild hydrocephalus. Otherwise the child was normal. The mother lacked both maxillary lateral incisors and all four third molars and the father lacked all third molars. The anomaly seems therefore to be inherited. In another brother who died at the age of 13 years the maxillary lateral incisors were missing.

Hotz published a case of heredity of anodontia combined with a very pronounced progeny (Class III) in a Swiss family. It was impossible to examine

the whole family and their relatives because there were so many members that it would have taken too much time. He promised, however, to continue with his examination and to report the results in a later publication. In order to get an idea of the number of family members, he writes that the parents had fifteen sons and daughters, eleven brothers and sisters, fifteen uncles and aunts, and twenty-five cousins. The fifteen brothers and sisters had twenty-seven cousins. This means that more than 100 persons would have to be examined in order to get a complete picture. The parents are not related as far as they know, even though they both have the same name; it is possible that there has been a relationship generations before. So far Hotz examined only the six sons and the nine daughters and gives the following table of their anomalies:

27-year-old female	5				5
	5	1	1		5
26-year-old female	54				45
	54	1	1		45
25-year-old female	normal dentition.				
24-year-old male	65				567
	65				567
23-year-old female	7654				567
	65				567
21-year-old male	5				5
	5	1	1		5
20-year-old male	765	2	2		5 7
	765	1	12		567
18-year-old female	765				567
	5				5
17-year-old male	65	2	2		456
	765	21	12		56
15-year-old male	765				6
	6	1	1		6
13-year-old male	65				56
	7 5	1	1		5 7
12-year-old female	normal dentition.				
9-year-old female	7 5				5 7
	5	1	1		5
8-year-old female	765	2	2		567
	7 5 3	1	1		5
5-year-old female	7 5				5 7
	5				5

Two of the daughters had normal dentures. Hotz did not include the third molars in his examination. The average number of missing teeth is 9⅐ teeth

per person in the females and eleven teeth per person in the male. This report was verified by x-ray examination.

The pedigree of the family is shown in Fig. 12.

ECTODERMAL DYSPLASIA IN ANIMALS

The lack of teeth associated with scant hair was also observed in animals. Examples are the toothless and hairless dogs of China and Japan. The probable explanation for this curiosity is that the characteristics of the disturbance of the exterior germinal layer are fixed in the hereditary plasma by inbreeding in such a degenerative way that a new breed originated with these characteristic malformations.

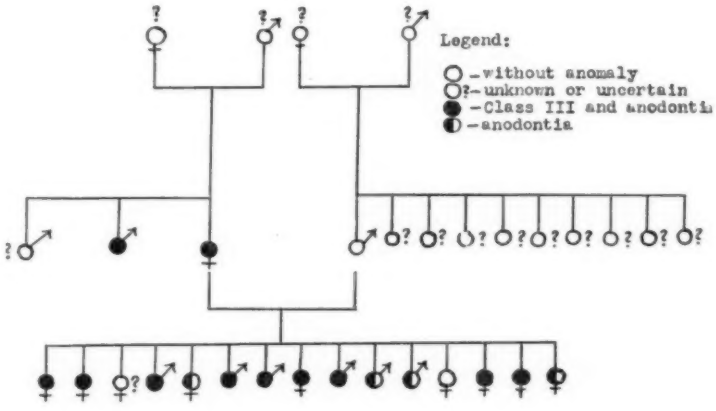

Fig. 12.

SUMMARY

However, the problem of the exact determinant of partial and total anodontia has not been completely solved as yet, and the present material on this subject is insufficient to insure a satisfactory conclusion. We can only strive at present to treat these cases properly as they are presented. A case report of partial anodontia is appended.

CASE REPORT

PARTIAL ANODONTIA AND ITS TREATMENT

I. M., female, aged 15 years, weight, 97 pounds, height, 63½ inches.

Medical history.—I. M. was a bottle-fed baby. There had been considerable difficulty in obtaining a suitable dietary formula. The diet consisted of acidophilus milk, fortified with orange juice and "Scott's Emulsion." The family physician at no time prescribed vitamins or calcium. The child was weaned from the bottle at 15 months but never received really solid food until 5 years of age. During this time she received no meat, only pureed vegetables, and milk only with cereals. Orange juice was continued, and other fruits added to the diet. At one period an "oxblood" tonic was given. Outside of this no tonics or additions to the diet were supplied.

She has always been a rather sickly child, slightly under weight, at all times with a rather rapid growth. She has had the following diseases at

various ages: mumps at 22 months, whooping cough at 26 months, chicken pox at three years, measles at 4 years, German measles at 5 years, scarlet fever at 6 years, nervous breakdown at 6 years, scarlatina at 9 years. Her tonsils were removed at 9 years, and she had a gall bladder disorder with jaundice at 12 years. A few years ago her hair fell out rather profusely but was always replaced. This complaint has entirely disappeared. Wassermann test was negative. Phosphorus and calcium contents were normal. The basal metabolic rate could not be determined because the patient did not return to the University Hospital for examination.

Dental History.—Her temporary teeth began to erupt in the fifth month, and by the twelfth month two maxillary and two mandibular incisors had appeared. Subsequently five more teeth appeared but the remaining eleven failed to develop. At approximately the fifth year the two maxillary incisors

Fig. 13.

were replaced by permanent teeth, and later a few more teeth appeared. Some of the deciduous teeth had to be removed because they were badly decayed. It could not be determined exactly what deciduous teeth were present and how many were removed, because of the late age that she came under dental observation in the university. The formula of her present-day dentition is as follows:

$$\frac{6\ C\ 1|1\ C}{C\ |\ C4\ 6}.$$

The two maxillary incisors are rotated and turned up and outward. The deciduous canines are all peg shaped. There are no buds of other teeth formed in the bone.

Summary of History.—A rather jumpy nervous child, slightly underweight, she has always been rather frail and suffered from many diseases of childhood including a severe case of scarlet fever at 6 years of age. She shows no evidence of rickets except a possible thickening of the inner ends of the clavicles. There is a slight mitral systolic murmur. There is no evidence of

developmental abnormalities or anomalies except for failure in development of many teeth. She is otherwise perfectly normal and is keen and intelligent.

There is a family history of the abnormality in the number of teeth. Her father has two peg-shaped lateral incisors and a sister of her father is reported

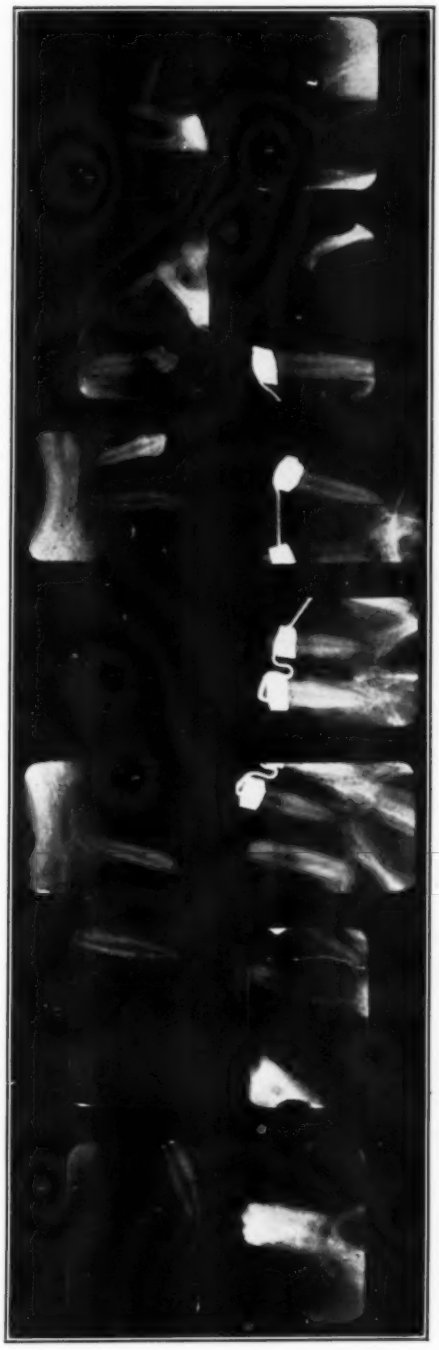

Fig. 14.—Full mouth roentgenogram of case of I. M.

to have some missing teeth. The mother comes from the South, and her family belonged to the "white trash." The child was not very well cared for at home, her diet being a very irregular one; the mother is inclined to drink

(information from the family physician). I. M. has a brother with all teeth present but in poor condition.

Treatment.—This consisted of restoring the decayed areas in the two molar teeth, in constructing a lower plate with two claps, and orthodontic treatment for the maxillary jaw. When orthodontic treatment is completed a denture of some form will be constructed.

Fig. 15.

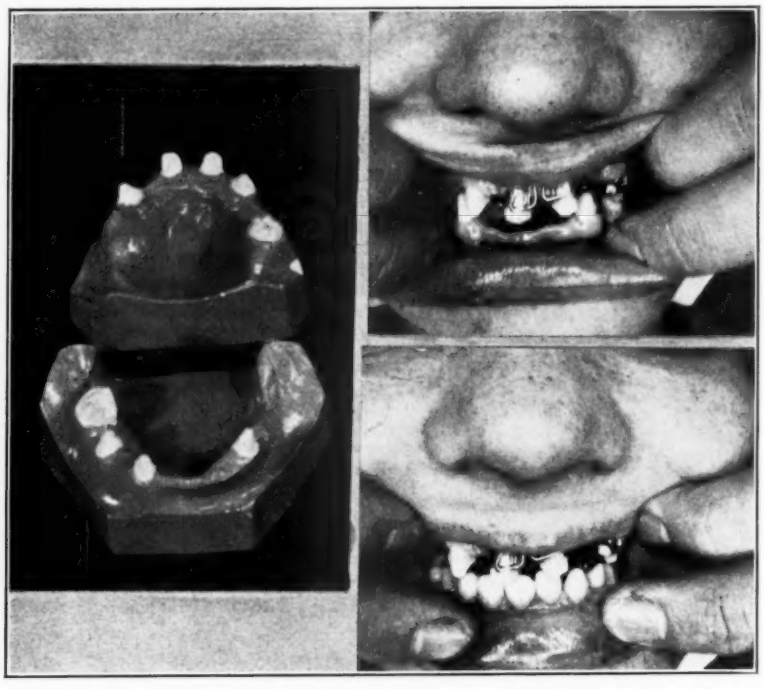

Fig. 16.

Fig. 17.

Fig. 15.—Models of the mouth of I. M.
Fig. 16.—Case of I. M. showing orthodontic treatment started in the maxilla.
Fig. 17.—Case of I. M. with mandibular denture in position.

The origin of this partial anodontia is, in all probability, hereditary, but seems to be influenced by environmental factors, diet, and diseases. It was impossible to get any information from the mother about her state of living during pregnancy and about the delivery.

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OSTEOMYELITIS OF THE JAWS FOLLOWING ACUTE MERCURY POISONING

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MERCURY poisoning has been recognized for at least two centuries, and the jaw necrosis associated with this condition has been observed in the older literature. The nature and distribution of the areas of bone destruction in the mandible and maxilla, however, have received little or no attention. Since mercury has lost the popularity it once enjoyed in medical practice, such cases are rarely seen at the present time. Two cases are herewith reported, one of which revealed a localized type of bone involvement, while the other showed extensive destruction of both the maxilla and the mandible.

In 1721 Antoine de Jussieu described the poisoning observed in workers employed in the quicksilver mines of Spain, these patients manifesting salivation, ulceration of the gums, and tremor. In 1829 Reitz described the hazards of mercury to those employed in the hatters' furriers' process, and in 1861 Kussmaul published his classical treatise on chronic mercurialism affecting those employed in silvering mirrors.

It is generally conceded that stomatitis may be a manifestation of either acute or chronic mercury poisoning. In the days of our medical ancestors mercury was employed more frequently and in larger doses than at present. For example, in 1826 Graves and Stokes reported two fatal cases in which extensive stomatitis developed after the administration of "small" doses of calomel (six grains in one case and eight in the other). Likewise, in 1846 Campbell Stewart reported the case of a child suffering from peritonitis treated with mercury, with the development of severe stomatitis and extensive necrosis of the jaw bones. Even today, the remark is occasionally heard in reference to the mercurial treatment of syphilis, "push the drug until the gums are touched."

All forms of mercury may elicit the picture of mercurialism. The more insoluble mercurous salts are much less toxic than the freely soluble mercuric compounds. Mercuric chloride exerts a twofold effect: it produces the usual mercurial effect and in addition, if ingested, proves intensely irritating to the entire gastrointestinal tract.

It is generally agreed that mercury provokes an inflammatory process by virtue of its accumulation in the involved viscus. Lambert and Patterson have proved that in mercurial poisoning the stomach secretes the drug for many days following its ingestion. Likewise, the stomatitis is probably not due entirely to the initial irritating effect of the poison. Hamilton, Sollmann and others

From the Western Pennsylvania Hospital.

have postulated that it also exerts its deleterious effects on the membranes during the process of elimination. Thus, in the well-known case described by Umber, the patient injected 2 c.c. of metallic mercury into an arm vein and developed stomatitis, in addition to the usual systemic signs and symptoms of mercury poisoning. Leschke mentioned a fatal case of mercurial poisoning in which stomatitis developed following the intravenous administration of novasurol. Almkvist has elaborated the theory that the stomatitis, as well as the colitis, is due to hydrogen sulfide produced by the process of putrefaction, this substance precipitating the mercury in the form of mercuric sulfide in the capillary endothelium in these locations.

Stomatitis occurs early in mercury poisoning, and in the acute form it may make its appearance within twenty-four hours. It is a remarkable fact that stomatitis rarely, if ever, occurs in the edentulous patient. The early lesions are prone to appear in pockets and other points of infection about the mouth. Wise and Parkhurst have made the statement that mercurial stomatitis will not occur in patients whose teeth, gums and buccal mucosa are kept clean and healthy. The patient with mercurial stomatitis presents a picture which is almost distinctive. The breath is foul, swallowing and speech are arduous and painful, salivation is profuse, taste is of a metallic nature, the mucosa presents diffuse redness and tenderness which are most pronounced about the teeth, grayish-white exudate is present, the tongue is swollen and often presents indentations opposite the teeth, a blue line may be present about the gingival mucosa, and the salivary glands are prone to be enlarged. Legge has described black pigmentation of the enamel, which we have not observed. In more advanced cases there may be respiratory distress due to edema of the larynx. The teeth may become loose and are sometimes removed by the patient with his fingers. As the teeth are shed, or as areas of ulceration appear over the alveolus, the bone is exposed. This is apt to become necrotic, particularly about the alveolus, and, due to superimposed infection, osteomyelitis develops. Spontaneous fracture occasionally occurs.

The explanation of the salivation may be on the basis of reflex stimulation or direct irritation of the salivary mechanism by the mercury. There is ample evidence in the literature to confirm the latter view. McNally favored this mechanism, and in 1913 Giani reported degenerative changes in the parotid gland.

The general symptoms of acute mercury poisoning are primarily those of gastrointestinal and renal irritation. Vomiting is prone to occur early and is often the first symptom. The patient complains of burning pain in the throat and in the epigastrium. Bloody diarrhea soon makes its appearance. In a few of the cases the patients are in a state of shock when first seen, Howard and others ascribing this to splanchnic vasomotor dilatation. Hematuria, albuminuria, oliguria, and even anuria may occur. The blood urea and the nonprotein nitrogen are increased, often to alarming levels. Lymphocytosis, polycythemia and poikilocytosis have been described. In late cases mental symptoms are prominent.

The lethal dose of mercuric chloride is variable. Sansum showed that 4 mg. of mercury per kg. of body weight was invariably fatal when injected into the circulation of the dog. He was of the opinion that the same ratio was applicable to man. In his work 5 mg. per kg. of body weight was required to produce anuria regularly. Underhill gave 3 to 5 grams as the fatal dose of mercuric chloride, and the fatal period as from one-half hour to two weeks. Gonzales, Vance and Helpern stated that death has resulted from as little as three grains.

Case 1.—The patient, male, aged 26, gave the history of having ingested three bichloride of mercury tablets (probably 7½ gr. each) two months prior to his present admission. Within a few minutes he began to vomit and was

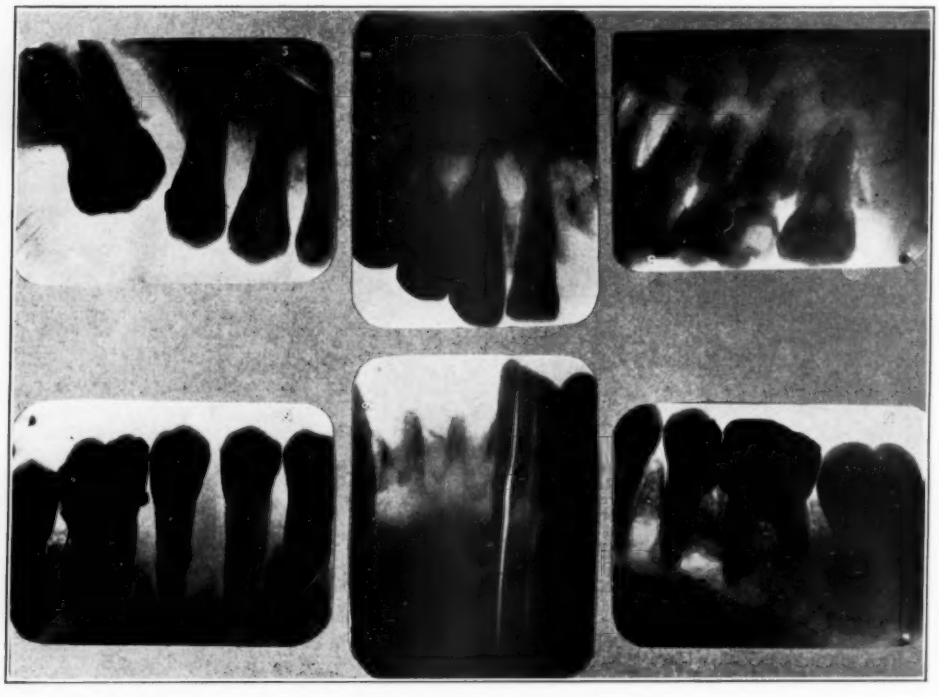

Fig. 1.—Dental films in Case 1, showing the extensive involvement of the maxillary and mandibular alveolus. Note that the bone destruction is limited to the alveolus, and does not extend into the bone beneath this level.

rushed to a nearby hospital, where gastric lavage was done. On the following day bloody diarrhea made its appearance, which persisted for several days, although the melena disappeared within twenty-four hours. There was no hematuria, and the urinary output was not appreciably diminished. Patient remained rational throughout his illness. Two weeks subsequent to the ingestion of the poison he complained of pain and swelling of the throat, with increasing difficulty in swallowing. Gastrostomy was performed for feeding purposes, and the wound was permitted to close after two weeks. Four weeks after taking the bichloride he first noted soreness of the mucous membranes of the mouth, which was most pronounced about the teeth. This became progressively more severe, areas of ulceration appeared, the teeth became very loose, and he removed several with his fingers. Although the exact details relative to the de-

gree of renal damage are not available, the urinary output remained practically normal and there had been no edema. During his illness the patient lost about twenty pounds.

At the time of admission to the hospital the patient was pale, mildly emaciated, the breath was foul, and he appeared to be in acute distress. The gastrostomy wound had closed. The oral mucosa was deep red in color, bleeding easily on palpation. The gums presented extensive sloughing about the teeth. Several teeth had recently been lost, the entire alveolus above and below was denuded, and the exposed bone was necrotic in appearance. The remaining teeth were very loose, and the alveolus above and below had separated from the maxilla and from the mandible, being quite movable.

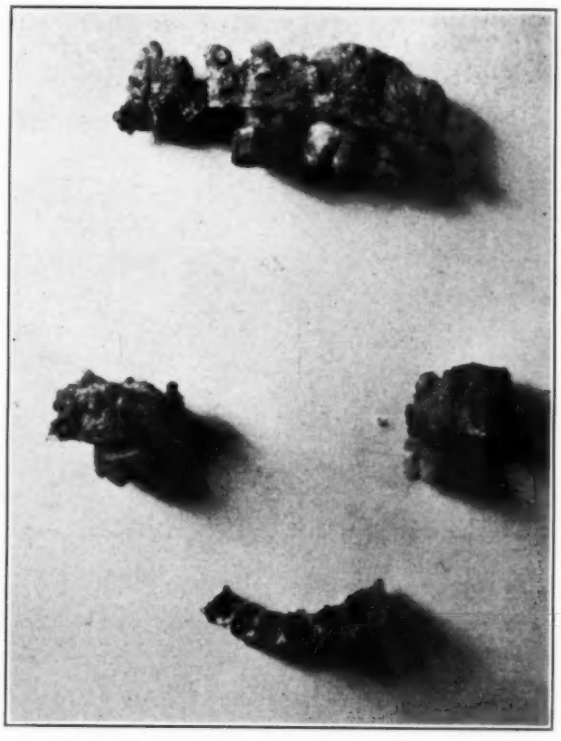

Fig. 2.—Sequestrae removed in Case 1.

The clinical laboratory examinations revealed surprisingly little of importance. On several occasions urinalysis revealed no casts and only a faint trace of albumin. The total phenolsulfonephthalein output was 57 per cent, the nonprotein nitrogen was 29 mg. per 100 c.c. of blood; serology was negative for syphilis, and the red cell count was 4,390,000, hemoglobin 85 per cent, white cell count was 9,700 and the differential white cell count showed no abnormality.

Roentgen examination of the maxilla and mandible revealed extensive destruction of the alveoli. The bone destruction is striking in that it extended only to the level of the apices of the roots of the teeth, the bone beyond this level being of normal appearance. The dental films are shown in Fig. 1. Sinus films revealed clouding of the right maxillary sinus, the left being normal.

At operation several large sequestra were removed. In one case three teeth were attached to a single sequestrum, while in the mandible the sockets of all six anterior teeth were present in another fragment (Fig. 2). A buccoantral fistula was present on the right. Subsequent to multiple sequestrectomy the gums were loosely sutured. No attempt was made to close the fistula. A nasal window was not established because of the gross infection present.

The postoperative course and recovery of the patient were remarkably smooth. He was given a mouthwash of potassium chlorate and placed on a high caloric diet. No therapy was directed to the infected antrum. Within three weeks following operation the buccal and lingual flaps of mucous membrane had united, and there was no further exudate. The buccoantral fistula closed with no special therapy toward that end. The patient was sent to a prosthodontist six weeks following the operation, and has had no further trouble referable to the mouth.

Case 2.—The patient, female, aged 14 years, gave a history of having ingested fifteen grains of mercuric chloride three months prior to the present admission. She was rushed to the hospital and gastric lavage performed.

Fig. 3.—Showing localized bone destruction in Case 2.

Despite this she developed severe renal damage. The blood urea was said to have been 280 mg. per 100 c.c. of blood. After a long course she left the hospital. No other details of her hospitalization are available. Several weeks following the ingestion of the poison she developed tenderness and bleeding of the gums. This was most pronounced on the left side, above and below, with milder involvement of the right side. The maxillary left posterior teeth became loose, and on the day prior to her admission she "lifted out" the maxillary first molar together with considerable alveolus, including the floor of the antrum.

The patient was a well-developed and fairly well-nourished girl at the time of her admission to the hospital. The maxillary left bicuspids were very loose, the breath was foul, the gums were markedly inflamed about the maxillary left posterior teeth, and to a much milder extent about the other teeth. The remaining teeth were not loose.

At the time of admission to the hospital the blood urea was 43 mg. per 100 c.c. of blood; the urine presented a moderate trace of albumin and a few hyaline and granular casts.

Roentgen studies revealed marked clouding of the left maxillary sinus, and the bony floor of the sinus had largely been sequestrated. The bone about the

distal of the maxillary left second bicuspid was almost completely destroyed, and there was some destruction of the interproximal bone between the bicuspids (Fig. 3).

Operation included only removal of the maxillary left bicuspids and the loose interproximal bone. No attempt was made to close the buccoantral fistula, and nasal antrotomy was not deemed advisable at this stage.

Following operation the patient did well except that the buccoantral fistula remained patent. The case was followed for six weeks, during which time the mucous membranes of the mouth became essentially normal. Patient was instructed to return in six months for a radical antrum operation with plastic closure of the fistula, but has not been heard from since that time.

DISCUSSION

Osteomyelitis of the jaws following mercury poisoning is entirely different from the commoner type of pyogenic osteomyelitis unassociated with mercurial necrosis of the alveolus. The usual osteomyelitis of the jaws most commonly arises from periapical infection, though it may arise from infection of a tooth socket following tooth extraction, or from a more superficially located mouth infection, such as pericemental or even a soft tissue infection of the mouth. More rarely osteomyelitis of the jaws is of hematogenous origin.

In the case of osteomyelitis in mercury poisoning the process is essentially a chemical necrosis of the bone, with superimposed infection, and consequent osteomyelitis. The peculiar nature of the pericemental bone destruction is possibly explainable on the basis of the accumulation of the mercury in the capillaries of the rich vascular network of the peridental membrane. We are of the opinion, however, that the process extends down from the necrotic gingival mucosa along the peridental membrane. In case the process is limited, the bone necrosis occurs in the area in which the stomatitis is most intense. The most striking feature of the process is its limitation to the alveolar portions of the mandible and of the maxilla, rarely extending much beyond the level of the apices of the teeth. It would seem that the accumulation of the mercury in the capillaries of the bone cannot be responsible for the necrotic process. If this were true the lesion would not be so demarcated and limited to the alveolar portions of the bones, since these bones are both quite vascular. We are thus inclined to the opinion that the necrotic process is largely attributable to the mercury present in the mouth.

The prognosis of osteomyelitis of the jaws associated with mercurial necrosis is excellent. The process is surprisingly self-limited and runs a fairly acute course. With conservative treatment, following by opportune sequestrectomy, the patient should ordinarily secure an excellent result.

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6109 Jenkins Arcade Bldg.

RETENTION CYSTS OF THE LIP (MUCOCELE)

SAMPSON S. HECHT, D.D.S.,* NEW YORK, N. Y.

RETENTION cysts occurring on the mucous surface of the oral cavity are known as mucoceles. According to Webster's Twentieth Century Dictionary, *mucocele* is described as [muco- + -cele]—"Any cyst containing mucus." The cyst, faintly bluish in color, is filled with a viscid fluid; and though it may occur throughout the oral cavity, it is most frequently observed in the lower lip opposite the canine and incisor teeth.

CASE HISTORY

B. M., an 18-year-old boy, presented himself to the medical clinic of the New York City Boys' Reformatory with a complaint of a swelling in the lower right labial region. He stated that it was uncomfortable. The resident physician referred him to the dental clinic.

History.—The patient, of Spanish descent, appeared undernourished and not overintelligent. The patient had been committed to the institution about four months prior to our present examination. His face was scarred and pockmarked. There was no history of syphilis, and the Wassermann test was negative. He said that he had first noted the swelling about a month before. When it became large enough to cause discomfort, he reported to the medical clinic.

Examination.—External examination in the region of the lower lip showed a slight bulge on the right side and one of smaller size on the left side. Laying back the lip, a bulge, bluish in color, and the size of a large almond, was seen on the right side of the median line. This mass extended from about one centimeter below the vermilion border of the lip to the mucolabial fold in the floor of the vestibule. In its mesiodistal aspect, it extended from the mesial surface of the central incisor to the distal surface of the cuspid. Upon palpation, the area felt soft and fluctuant and did not appear to be attached to the skin or bone. No concretions were visible or palpated.

Examination in the region of the left labial aspect showed a second protuberance, the size of a hazelnut. It extended from about one centimeter below the vermilion border of the lip to the mucolabial fold. In its mesiolingual aspect, it extended from the distal of the lateral incisor to the distal of the cuspid. However, this was not so pronounced as the right nor as elevated from the level of the normal mucous membrane. It was more nodular than the first and had minute concretions in it. The patient stated that he had never noticed this second enlargement and thought that it might have developed in the past week.

*Dentist in charge of Women's House of Detention and Tombs Prison, New York City. Former Visiting Oral Surgeon at the New York City Boys' Reformatory.

Further examination of the mouth revealed that the patient's teeth were hypoplastic and covered with a peculiar yellowish-green stain. No caries nor pyorrheal involvement was apparent. The mucous membrane and the gum of

Fig. 1. Fig. 2. Fig. 3.

Fig. 4. Fig. 5. Fig. 6.

Fig. 1.—External view of bilateral mucocele.
Fig. 2.—Left mucocele of lower lip.
Fig. 3.—View of right mucocele.
Fig. 4.—Another view of mucoceles.
Fig. 5.—Retraction of the lip showing both mucoceles.
Fig. 6.—Clamps in place to prevent bleeding during operation.

Fig. 7.—Photograph of excised mucocele of right side of lip.

the mandibular anterior teeth were stippled and did not have the normal pinkish look. Instead, there was a frosted appearance, as when tissue is sprayed with ethyl chloride. Diagnosis was bilateral mucocele of the lip.

Operation.—Novocaine with suprarenin was the anesthetic of choice. We used the subcutaneous circuminjection entering the tissue from the vermilion border and placing a few drops of novocaine as we went along until the vestibule was reached. We then withdrew the needle slightly and went down the angular side of the mass, depositing a few drops as we went along, until the vestibule was reached.

We then applied hemostats and compressed the lips on either side of the mass. The ends of the hemostats were protected by rubber tubing. With a Bard-Parker No. 10 blade, an elliptical incision was made through the mucous membrane from the vestibule to the lip up to the vermilion border on right and left. Then, by means of blunt dissection, the submucous tissue was dissected away. As we dissected, small pealike masses popped up. These were small mucous glands. Continuing the blunt dissection, we soon came upon a straw-colored inflated sac which proved to be the enlarged mass. This was dissected out and sent to the pathological laboratory.

The edges of the wound were coapted, and a suture was placed at the apex of the vestibule and another at the apex of the lip. The rest of the suturing was completed by means of the Stewart suture.

The Stewart suture is made thus: Using a straight needle, we enter the edge of the mucous membrane from one side and then the other side. Now, we reenter the tissue about a quarter of an inch below the last exit point and pass the needle across and through the deep tissue and come out about one-quarter of an inch below the first point of exit. Now the sutures are drawn together and the edges are found to invert. About five such sutures were placed. The material used was black silk, numbers one and five. The pea-sized glands kept popping out and had to be pushed in as the sutures were drawn.

The operation took three-quarters of an hour. There was very little bleeding and the anesthesia was very good. There was an uneventful recovery. The second retention cyst was removed the following week without incident.

Comment.—Complete resection of the cyst is essential. Any piercing of the cyst without complete excision causes recurrence. Since there was no x-ray machine available at the institution, no roentgenograms were taken of the area. Roentgenograms were taken of the extirpated cyst; and several small radiopaque areas, the size of large pinheads, were seen in the pictures. The specimen sent to the laboratory for histological examination was lost. The second cyst has not been examined histologically. It is being kept for exhibition purposes.

TIMES BUILDING

Case Reports

A case report dealing with prosthetic reconstruction of a deformity resulting from surgical excision is presented this month. Readers are invited to send reports and discussions to the editor, Dr. Kurt H. Thoma, 47 Bay State Road, Boston, Mass.

CASE REPORT NO. 22

CONSTRUCTION OF A NOSE BY PROSTHESIS

ROLAND S. CLAFLIN, D.D.S., M.D.S., CHICAGO, ILL.

Mr. P., aged 71 years, a cigar manufacturer, developed a squamous cell carcinoma on the dorsum of the nose. After other methods of treatment had failed, the nose was removed surgically in the fall of 1936. His physician advised against surgical restoration of the nose because of his age. Mr. P.

had been free from any sign or symptom of metastasis of the tumor for eighteen months; therefore, his physician thought he could wear an artificial nose without any danger of irritating the tissue. He referred Mr. P. to me and suggested that perhaps a nose could be constructed out of some material and through some process used by a dentist.

The first step was the taking of a dentocoll impression. The cast from this impression was used as a master model upon which to work. A nose was modeled upon the cast with clay, earlier photographs of Mr. P. giving an approximate idea of the form. Then a sectional impression was made of the clay model in place on the master model. The inside of this sectional impression was waxed with 26 gauge wax and cast in Vitallium. This light metal

casting of the nose was then soldered to eyeglasses to hold it in place. The outer surface of the casting was covered with wax and colored to match the skin. The weight of the Vitallium casting was ⅝ of an ounce.

This method of construction proved very successful after other methods had been tried with less success. Attaching the nose to the eyeglasses was the only solution, because in trying to use the nostrils as a base, it was found that the artificial nose moved with the movements of the patient's upper lip. The photographs show Mr. P. without and with the artificial nose.

An interesting observation in relation to this case is that Mr. P.'s brother, two years his senior, who also is a cigar maker, developed a carcinoma in approximately the same location within the last year.

The significant result of this piece of work is that it has completely changed the mental attitude of Mr. P. from that of a recluse to a man confidently taking his place in social life again.

3724 Fullerton Avenue

Department of Orthodontic Abstracts and Reviews

Edited by

DR. EGON NEUSTADT, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. Egon Neustadt, 133 East Fifty-Eighth Street, New York City.

The Significance of the Teleoroentgenogram in Orthodontic Treatment. By Prof. Dr. G. Korkhaus, Bonn. Abstracted from *Fortschritte der Orthodontie,* Vol. III, No. 3, 1936.

For the purpose of orienting the patient's head, Korkhaus has designed an instrument which, in some respects, is similar to the one used by Broadbent (Fig. 1). It is fitted with two pointers for the tragia and with four profile-pointers which enable the operator to place the sagittal plane of the head parallel with the plane of the film and perpendicular to the center ray; it also helps in locating the bitragial point without the possibility of an error. The roentgen tube is placed ten to fifteen feet away from the patient's head, and

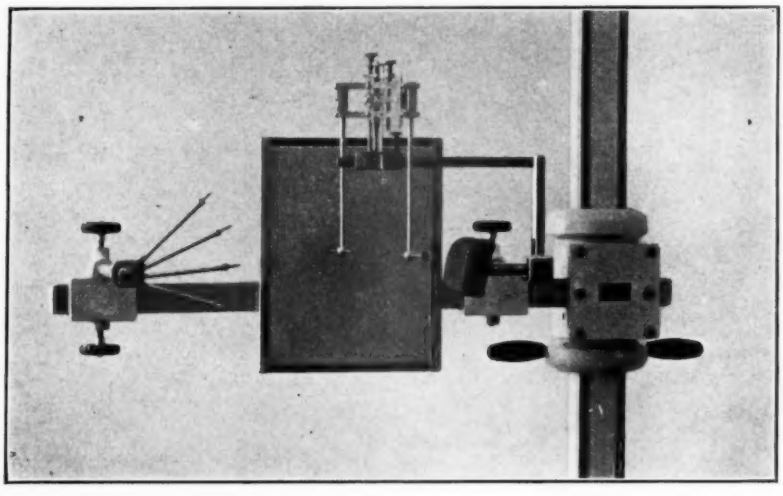


Fig. 1.

it is centered by means of a telescope mounted on the tube. In order to make the soft tissues of the face stand out clearly, Korkhaus suggests a method of film reduction (Hofrath) in which case the exposure of only one film is necessary.

The diagnostic evaluation of the teleoroentgenogram should be conducted in several steps, the first one being the examination of the teeth themselves and of the alveolar bone. For this purpose, the axis of the teeth is drawn in, which makes it possible to determine the pyramid of the dentition (Gebiss-

kegel, Cieszinsky); in a like manner, the following are then determined: the angle between the plane of occlusion and the tooth axis; deviations in the vertical elevation of teeth with regard to the plane of occlusion; the position of tooth germs; and the proportion of crown length to root length of individual teeth.

The second diagnostic step concerns itself with the relative position of teeth and the alveolar process to the body of the jaw bones. In this connection, it is of great interest to observe the relationship of two angles (Fig. 2): one which is formed between a (fictitious) plane of occlusion *(KE)* and the

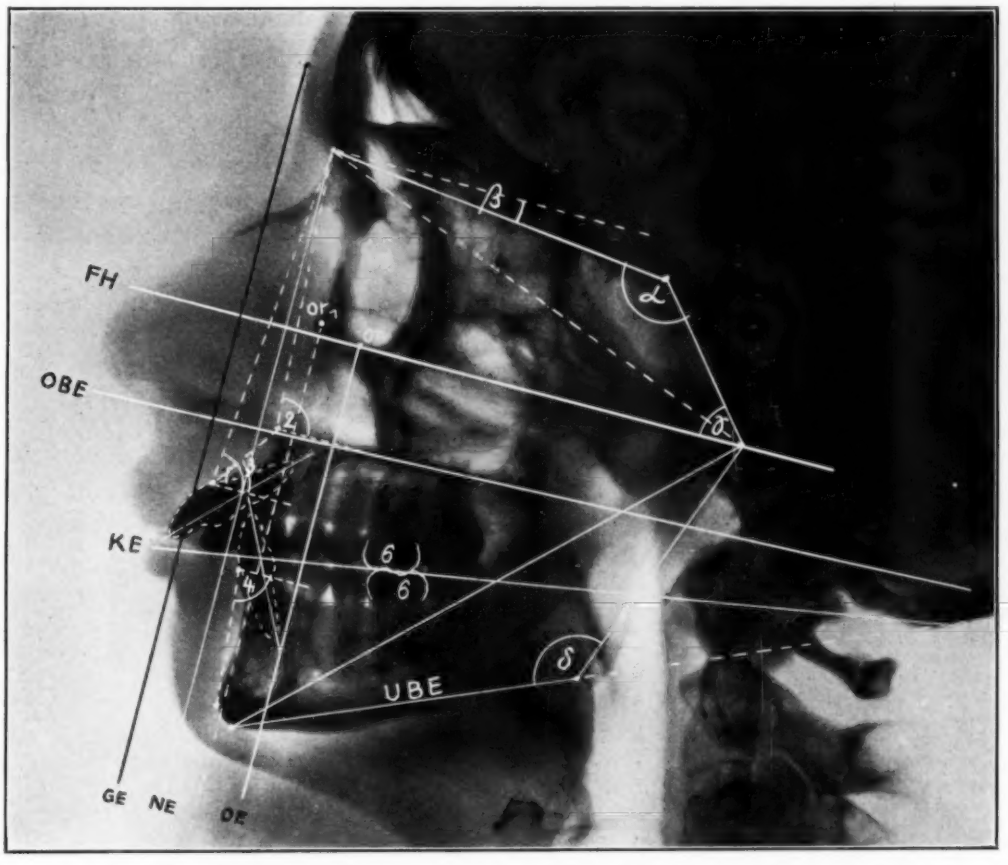


Fig. 2.—Teleoroentgenogram, taken at a focal-film distance of 4 M. (12 ft.) by means of Dr. Korkhaus' orientation instrument (60 Ma. and 100 kv., 2 seconds exposure).
FH, ear-eye plane; *OBE*, plane through basis of maxilla; *UBE*, plane through basis of mandible; *KE*, plane of occlusion; *GE*, plane through glabella; *NE*, plane through nasion; *OE*, orbital plane; ∠α, sphenoid angle; ∠β, nasion basis; ∠γ, tragion basis; ∠δ, angle of mandible; ∠1, total profile angle; ∠2, nasal profile angle; ∠3, alveolar profile angle; ∠4, mandibular profile angle.

basis of the maxilla *(OBE)* and mandible *(UBE)*; another which is formed by the basis of the jaw bones themselves. The observation of the angle of the mandible is especially of importance, as well as the growth of the alveolus in length and height.

The third phase of diagnosis deals with the location of the profile points (skin points and bone points) with respect to glabella *(GE)*, nasion *(NE)*, and orbital plane *(OE)*, and the following angles are studied—the profile

angles (∠s *1, 2, 3, 4*), the angles formed by the ear-eye plane and maxilla-basis, and the plane of occlusion.

The fourth and last part of the diagnostic studies concerns itself with the relationship of the facial bones to the cranium. The inclination of the cranial base to the ear-eye plane and the modified sphenoidal angle ∠α (Welcker) belong in this section.

After completion of these analytical examinations, the findings are compiled in diagrammatic form on paper divided into squares, as suggested by DeCoster. This furnishes a comparison of the profile diagram with the biometric norm. From the variations from normal noticeable in the chart, zones of excessive or retarded development can be ascertained.

This systematic evaluation of the teleoroentgenogram affords an extraordinary insight into biogenetic developments and is, for this reason, invaluable in every orthodontic examination. Even the sciences dealing with racial and constitutional studies will be able to use this method successfully; the possibilities of it cannot yet be fully determined.

Dr. Hausser, Bonn.

Editorials

Thumb-Sucking

On account of the obvious divergence of opinion that exists in regard to the damage which may result from the habit of thumb-sucking in children, it is thought that the following letter to the editor, as a comment by one who has done much work upon the subject, may be of considerable interest to the readers of the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY, particularly to the orthodontists.

Editor.
December 20, 1938.

H. C. Pollock, D.D.S.,
Editor,
The American Journal of Orthodontics and Oral Surgery,
St. Louis, Missouri

My dear Doctor Pollock:

I have read with interest your editorial entitled "Orthodontic Paradox" and should like to comment upon your statements concerning the divergent views of the effects of thumb-sucking held by pediatricians and orthodontists.

I am in complete agreement with your observation that pediatricians, and I may add, some psychiatrists as well, too often base their judgment and advice on clinical observations and personal opinion alone, and that the trend among them is toward the view that the habit is one of little consequence, which may safely be ignored. Their advice to parents is based upon such a view.

It is a view which is proved unsound by the facts. Over a period of years I have observed and reported the effects of thumb-sucking in a considerable series of cases. The results of the studies show conclusively that there is a definite type of deformity of the dental arches produced by thumb-sucking; that if the habit is broken early enough, the deformity corrects itself naturally; but that if the habit persists, the deformity also persists.

It has been shown, both by Korkhaus and myself, that this characteristic deformity produced by thumb-sucking may be seen in the edentulous jaws of the baby, in some cases as early as three or four months of age; and when the habit persists, the effects are seen later not only in the jaw but in the occlusion of the teeth as well, and especially in the maxillary anterior teeth.

It may be of some passing interest and entertainment to mention again in this connection the case of the finger-sucking monkey, reported by Kelsey, in which the habit produced the same type of deformity as that seen in thumb-sucking children.

It appears, therefore, that the weight of scientific evidence is all on the side of the orthodontist's view of the habit as one which may have serious consequences for the child.

I believe, however, that something is to be said for the pediatrician's view. It is probable that he is familiar with children who have suffered harm from unwise methods used by parents in trying to break the habit, or by a nagging insistence that may make the results of the cure appear worse than those of

the disease. However, the orthodontist might counter with what he sees of the later psychological damage to the child when the habit persists. It is the orthodontist who sees the feeling of inferiority caused by protruding teeth and deformed jaws.

My opinion is that both orthodontists and pediatricians will profit by a sane and reasonable taking of stock on their views and practice in the matter. To the orthodontist who may be inclined to regard the habit as something that must be eradicated immediately and at all costs, it may be pointed out that unwise methods of breaking the habit are themselves a hazard to the child, and that, moreover, self-corrections of the deformity resulting from the habit have been observed as late as the age of nine and ten years, when the habit has been broken. To the pediatrician it may be pointed out, no less, that, personal views to the contrary, the habit is one which scientific observations show may have serious consequences, and which cannot be safely ignored.

It would seem that members of these two professions who deal with the problem of thumb-sucking in children will profit mutually by pooling their experiences and coming to some common middle-of-the-road position, which will be wisest for both the psychological and physical welfare of the children concerned.

(Signed) *Samuel J. Lewis, D.D.S.*
308 David Whitney Bldg.
Detroit, Michigan.

Orthodontic Appliances of Laboratory Origin*

Truth is the basis of progress. As leaders strive for and make progress, it sometimes happens that they have so outdistanced their colleagues that truths, newly proved, are viewed with skepticism and, indeed, sometimes are rejected at first. This is the unfortunate and vexing predicament of orthodontics today. As a result, practices are prevalent which are based on a completely wrong concept. The most untenable and harmful of these is the orthodontic appliance designed and made in the dental laboratory. By invitation, it becomes my privilege to present some truths proved through years by leaders in specialized practice.

A. An orthodontic appliance is potent either for good or harm in the mouth. It has no inherent intelligence and can act only as mechanically directed. It cannot be beneficial unless it is correctly adjusted, and this depends wholly on the intelligence and skill of the operator. If the appliance remains passive without regular adjustment and cleansing of the teeth, it is potentially harmful to the patient and, therefore, to the dentist.

B. The mechanisms made for dental restorations and those for orthodontic treatment are essentially different in purpose. Dental prosthetic appliances are substitutes for lost teeth and contiguous structures, and their success is dependent upon the unchanging durability. They are intended and made to remain passive. Orthodontic appliances, in order to produce results, must be active and regularly adjusted in order to maintain activity which is

*Printed by arrangement with the New York Journal of Dentistry.

the essential factor in stimulating growth and structural changes in the jaw tissues necessary for improvement. They are successful only as they are capable of properly inducing teeth to move into normal positions. To accomplish this, orthodontic appliances must be progressively changed. This requires not only repeated reshaping, but also the substitution and addition of parts as treatment progresses; this is much more difficult to accomplish with the bulky, low-grade appliances commonly designed and made in the dental laboratory. An orthodontic appliance is, therefore, not a passive, harmless thing in the mouth. It must result either in good or harm as long as it is worn. The dentist, and not the laboratory, is responsible to the patient, and the outcome depends wholly on the honesty of the practitioner.

C. Dentists are not schooled upon graduation to give orthodontic treatment. No dental college has ever claimed or even pretended to prepare its students in the undergraduate course for any kind of specialization. Therefore, the general practitioner is unprepared until he has mastered an adequate graduate or postgraduate course. Over thirteen university dental schools are now offering such courses in orthodontics.

D. Proper diagnosis, case analysis, and planning of treatment are the first essentials to success. Seven steps are necessary:

1. Personal examination of patient is essential.
2. History—as complete as possible.
3. Thorough check-up of nasal region and air passages (by rhinologist) when indicated.
4. Complete set of intraoral radiograms, supplemented by extraoral pictures when indicated.
5. Casts of teeth from accurate impressions.
6. Photostatic facial reproductions.
7. Graphs or plane reproductions of the casts—very helpful.

Not one step can be omitted without sacrificing thoroughness.

E. Dental casts cannot possibly portray the conditions necessary for proper treatment-planning. This commonly prevailing practice by dental laboratories the nation over is resulting in immeasurable harm to countless thousands of children. No orthodontist, worthy of the name, would think of assuming the responsibility of treatment without a personal examination of the patient and the weighing of all obtainable factors before proceeding. And it is inconceivable that any dentist, worthy of the name, could allow himself to undertake orthodontic treatment based on laboratory diagnosis and with appliances planned by a dental laboratory from casts only, after having been informed of the seven steps necessary for thorough diagnosis. The personal examination of the patient is invariably the first essential.

F. Orthodontic appliances are only one of the seven recognized agencies in treatment. They should be used only when imperative and then worn for as short a period as is possible to produce satisfactory results. There are seven divisions of treatment as follows:

1. Physiologic—thorough use in mastication, deglutition, speech, and breathing.

2. Psychologic—habit breaking, clear enunciation, thorough functioning.
3. Artificial exercisers—rubber bite straps.
4. Myofunctional therapy.
5. Medical aid as by the pediatrist and rhinologist—patients should be referred whenever indicated.
6. Surgical—as removal of supernumerary and impacted teeth, exposure of impactions to aid eruption, repair of cleft palate, or cleft lip.
7. Appliance therapy.

Treatment is frequently best given by a combination of exercises with appliances.

G. The commercial dental laboratories are less to be blamed than those members of the dental profession who patronize them. The laboratories must not be censured for legitimately increasing their earnings. Their success is based upon the amount of money they can make and transfer from their business into their private accounts. They have no responsibility to the patient for the results produced by the mechanism they make. The dentist is fully responsible, and his success must be based upon the good he can bring about for his patients. His financial reward ultimately depends upon this. The designing and making of appliances by the laboratory is the equivalent of diagnosing and prescribing treatment. Every orthodontist knows that this is impossible by the means legally available to the laboratory. It can only be the uninformed, unthinking, and the unscrupulous practitioner who would attempt treatment under these absolutely inadequate conditions. It must be they who make profitable the advertisements for orthodontic appliances, otherwise laboratories would not pay for the space.

The foregoing has been prepared by invitation. The statements are made with deep conviction after an experience and observation of fourteen years in general dental practice with an inclusion of some orthodontic patients, followed by almost a quarter century of exclusive specialization and teaching. The uncertainty, anxiety, and high percentage of failures in the early efforts of mixed practice are vividly remembered with repentance. There was, then, no adequate course of instruction available.

Orthodontics is recognized as a distinct branch of dentistry and is probably the most definitely defined specialty in dentistry. Only by concentration on orthodontics as an exclusive specialty has it been possible for its leaders to develop the high standards attainable today. More has been garnered and applied from collateral science than in any branch of dentistry. Excellence in daily practice has its basis in the fundamentals of biology. Success in treatment depends upon the scientific application of these to the problems of each individual case in stimulating growth and developmental and tissue changes in response to proper orthodontic treatment. Nothing less can, in the light of present knowledge, be recognized as true orthodontics worthy of its place as a specialty of forthright dentistry.

L. M. Waugh.

In Memoriam

Albert William Crosby

Dr. Albert William Crosby, for forty years an outstanding American orthodontist, died on Nov. 11, 1938, at the age of 68 years at his home in New Haven, Conn. He had practiced in New London twenty years and in New Haven twenty-seven years.

Many honors were conferred upon Dr. Crosby in his lifetime. He has been president of the Connecticut State Dental Association, the New Haven Dental Association, the New London County Dental Association, the Graduate

Albert William Crosby

Association of the Angle School of Orthodontia and of the Horace Wells Club, and was a member of the American Board of Orthodontics. He was a trustee of the American Dental Association and grand master of the Connecticut auxiliary of his fraternity. For nine years he was Dental Commissioner of the State of Connecticut and belonged to several honorary dental organiza-

tions. He was a member of the European Orthodontological Society and the American Association for the Advancement of Science, and of Omicron Kappa Upsilon fraternity.

His hospital, clinic, and teaching affiliations included eight years as clinical instructor of dental surgery at Yale School of Medicine, eight years as attending orthodontist at New York University, and four years as associate clinical professor of dental surgery at Yale School of Medicine, a position which he held at the time of his death.

Dr. Crosby was a founder and has been president of the New Haven Collectors Club. His collections of martingale brasses were derived from international sources and cover several centuries. He was a Thirty-second Degree Mason, a member of the Thames Club of New London, the Quinnipiack Club, the Chamber of Commerce, the Yale Alumni Association and of the Rotary Club of New Haven.

He was born in Hartford, Conn., the son of William Andrews and Alice Isola Crosby. He was a descendant of Simon Crosby, who came to Cambridge, Mass., in 1636 and became a selectman of that town, and of John Andrews, one of the founders of Farmington. He received the degree of D.D.S. from the New York College of Dentistry in the class of 1892 and took special courses in the Yale Medical School, the New York Post Graduate Medical School and Hospital and in the Manhattan Eye, Ear and Throat Hospital. He married Isabel Selden Darrow of New London, April 25, 1900, who survives him. There are no children.

To be able to crowd in so much activity in only one lifetime is characteristic of the man who was so highly respected in orthodontic circles; he was another one of the pioneers who became an international figure in his work. His name and memory will be held in deepest respect and affection for his contribution to orthodontics, and for his energetic and useful life. Dr. Albert Crosby is gone but he will be remembered as a sincere, wholesome, and highly respected orthodontist among his confreres throughout the world.

H. C. P.

News and Notes

Sigma Epsilon Delta Convention

Sigma Epsilon Delta fraternity will hold its annual convention at the Hotel Pennsylvania in New York City on Sunday, Jan. 8, 1939.

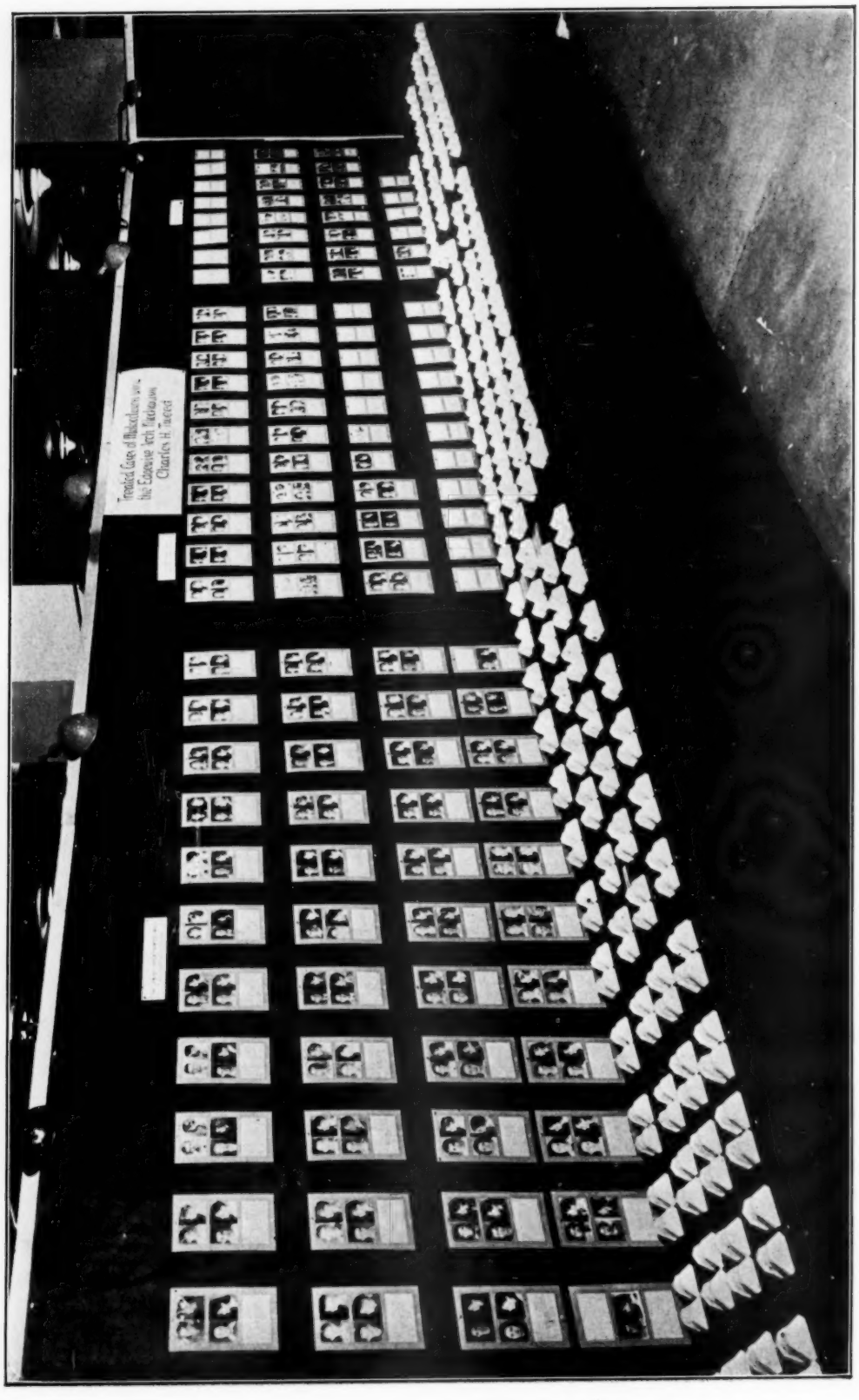
DR. DANIEL M. KOLLEN
24 Central Park South
New York, N. Y.

Dr. Oliver W. White, Detroit, Mich., newly elected member of the American Board of Orthodontists to fill the place of the retiring member, Dr. Frank Casto. Dr. White's term is for seven years.

Five State Post Graduate Clinic

The Annual Five State Post Graduate Clinic will be held March 5-9, 1939, at the Mayflower Hotel, Washington, D. C. Exhibits, clinics, features, and frolic will be included in the program.

A. G. MILLER, Chairman
Publicity Committee



The Charles H. Tweed Orthodontic Exhibit

The Charles H. Tweed Orthodontic Exhibit

The exhibit of treated cases of malocclusion was presented before the American Dental Association meeting in St. Louis, Oct. 24 to 28, 1938, by Dr. Charles H. Tweed of Tucson, Ariz. It was divided into three groups, as follows:

Group 1 consisted of fifty consecutively retained cases, all completed within a period of eleven months and nineteen days.

Group 2 was comprised of forty-five selected treated cases all under various phases of retention.

Group 3 was composed of thirty cases in which the patients have been completely free of any retaining device for periods of time ranging from one to eight years.

The orthodontic appliance used in the treatment of these 125 cases was the Angle edgewise arch mechanism.

The purpose of the exhibit was to plead for earlier orthodontic intervention and a more thoughtful application of mechanical principles, especially in the treatment of malocclusions occurring in mixed dentures.

American Association of Orthodontists

The Thirty-Seventh Annual Meeting of the American Association of Orthodontists will be held in Kansas City, Mo., April 17-20, 1939.

CLAUDE R. WOOD, Sec.-Treas.
Medical Arts Building
Knoxville, Tenn.

Southwest Dental Congress

At the Southwest Dental Congress, the eight states postgraduate meeting, will offer 180 hours postgraduate study in nine sections in Oklahoma City, Okla., April 24-28, 1939.

HARRY H. SORRELS
General Chairman
Medical Arts Building
Oklahoma City, Okla.

Southwest Dental Assistants Association

The Southwest Dental Assistants Association will meet in Oklahoma City, Okla., April 24-28, 1939.

Midwinter Dental Clinic

Every ethical dentist of the Southwest who is a member of the Texas State Dental Society or the American Dental Association is cordially invited to attend the Twelfth Annual Meeting of the Midwinter Dental Clinic, sponsored by the Dallas County Dental Society, Monday, Tuesday, and Wednesday, Jan. 30 and 31 and Feb. 1, 1939, at the Hotel Adolphus, Dallas, Texas. At this clinic Dr. Raymond E. Johnson of St. Paul, Minn., will present a course entitled, "Periodontoclasia." Dr. J. Raymond Gill of San Francisco, Calif., will present "Crown and Bridge and Dental Ceramics." Dr. Clarence O. Simpson of St. Louis, Mo., will present "Efficient Radiodontic Service" and Dr. Victor H. Sears of New York City, "Immediate Denture Technique."

The fee for this course is $15 which includes a ticket to the banquet, Tuesday, January 31. At this banquet, table clinics will be presented by members of the Dallas County Dental Society.

DR. THOS. A. LIPSCOMB.
Medical Arts Building
Dallas, Texas.

Southern Society of Orthodontists

The seventeenth annual meeting of the Southern Society of Orthodontists will be held at Hotel De Soto, Savannah, Ga., on March 6 and 7, 1939. All ethical members of the dental and medical professions are cordially invited to attend.

Dr. Sam G. Cole, President
Medical Arts Building
Atlanta, Ga.

Examination for Appointment in the Dental Corps, Regular Army

An examination for the selection of candidates for appointment in the Dental Corps, Regular Army, will be held during the period Feb. 13-18, 1939.

The examination, which will include both physical and professional examinations, the latter consisting of written, oral and clinical tests, is open to male citizens of the United States between the ages of 22 6/12 and 31 6/12 years at the time of the examination who are graduates of acceptable dental schools and who have had at least 1 11/12 years' subsequent practice in their profession.

Full information and application blanks will be furnished upon request to the Adjutant General, War Department, Washington, D. C. Applications will not be considered after Jan. 31, 1939.

Massachusetts Dental Society

The seventy-fifth annual meeting of the Massachusetts Dental Society will be held at the Hotel Statler in Boston, Mass., April 24-27, 1939. The subject of the meeting will be the "Trend of Dentistry During the Last Seventy-five Years." There will be outstanding speakers from all over the country, a health exhibit, and a clinical program.

Dr. Frank W. Rounds, President,
270 Commonwealth Avenue,
Boston, Mass.

Chicago Dental Society

The 1939 Midwinter Meeting of the Chicago Dental Society will be held February 13-16 inclusive at the Stevens Hotel. The meeting will once again return to its four-day length after an experiment with a five-day session last year. In 1938 the Midwinter Meeting achieved new records in attendance, with more than ten thousand visitors being registered during the five days. Greatly enlarged commercial and scientific exhibits were also features which will be continued for the 1939 meeting.

Xi Psi Phi, Golden Anniversary

The golden anniversary celebration of the founding of Xi Psi Phi will be held at Ann Arbor, Mich., Feb. 8 and 9, 1939. An elaborate program has been arranged which includes the unveiling of a memorial on the campus of the University of Michigan, in commemoration of the founding. The founders will be guests of honor. All Xi Psi Phi's are urged to attend.

J. Floyd Alcorn, General Secretary,
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